OUR HOME RAILWAYS

HOW THEY BEGAN AND HOW THEY ARE WORKED

W J GORDON

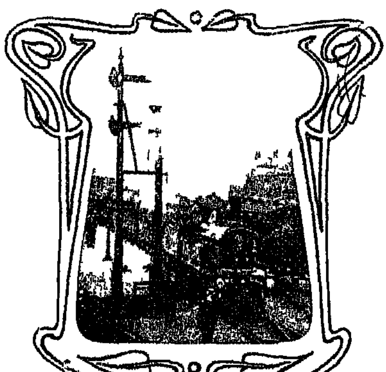
AUTHOR OF "EVERYDAY LIFE ON THE RAILROAD" "FOUNDRY, FORGE, AND FACTORY" ETC ETC

WITH 35 ORIGINAL COLOURED PLATES

By W J STOKOE

AND

300 ILLUSTRATIONS FROM PHOTOGRAPHS



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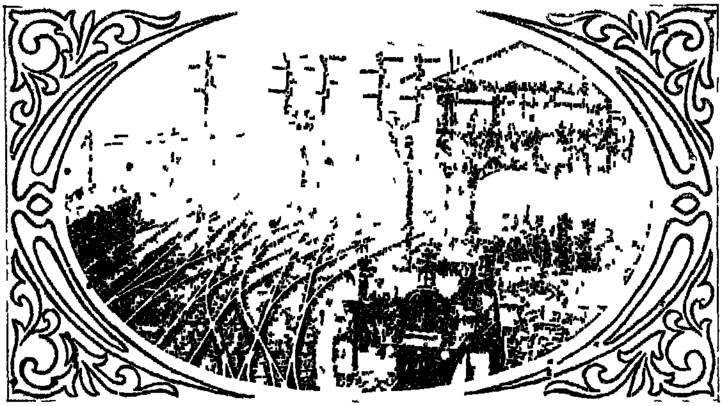


PREFACE

In 1788, two years after Murdock had made his model steam locomotive, Erasmus Darwin, the friend of Watt and Boulton, published the poem in which occur the lines—

> Soon shall thy arm, Unconquer'd Steam, afar
> Drag the slow barge, or drive the rapid car,
> Or on wide-waving wings expanded bear
> The flying chariot through the fields of air

an intelligent anticipation of the future—not quite a prophecy considering the facts on which it was based—which was never quoted with greater effect than on the 9th of April 1849, when the South Stafford was opened from Walsall to Lichfield, and the chairman, Mr C S Forster, recalling the then forgotten stanza, pointed out that with a degree of prescience truly wonderful the Lichfield poet had ventured on a prediction fulfilled to the very letter within the walls of his own city

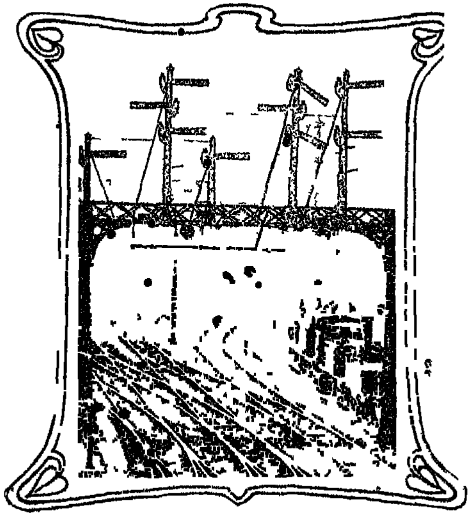
Since Darwin's day the development has been great,

PREFACE

The story of how it came about is briefly told in these pages on the growth of the British railway system, which incidentally describe the principal branches of railway work. It is not in all ways the old story, for the discovery of old working drawings and business letters, and the publication of Pease's and other diaries and papers, have in many cases greatly modified the usual version, as have also the references to the patent specifications, the Acts of Parliament, the prospectuses, and the contemporary reports of the companies' meetings, and, in the endeavour to ensure the statements on these and other matters being correct, every article has been submitted to the companies for approval, so that it is the first book on the general subject which has been officially verified and illustrated throughout from official sources

The illustrations are over 300 in number, and include a series of coloured plates of engines carriages, and armorial bearings from photographs, pictures, and transfers In many cases the photographs were specially taken for the work, and the most cordial acknowledgments are due to the managers, locomotive superintendents, engineers, and others who have so kindly assisted in its preparation, and who are far too numerous to be thanked individually, as the list would extend to several pages and contain the higher staff of every company it has been possible to include.

W J G.



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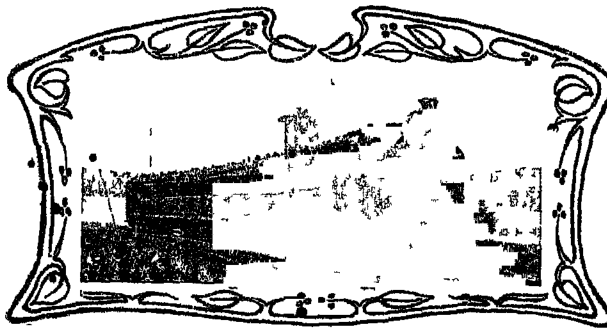

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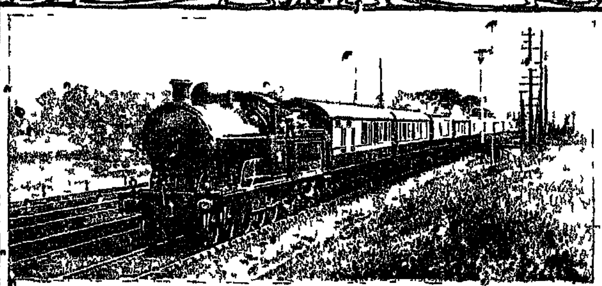


FOREWORD

HAVE you ever tried to think what is the oldest human achievement, what is the thing which can be traced back to the earliest times and still exists as a practical necessity from which we have never been able to escape, something which is older than the rudest implements of warfare or husbandry, older than song and story or books or written communication? It is the making of roads.

On a bright September morning in many a quiet valley, from the edge of the wood stretching down the slope to and across the valley levels, you shall see hundreds of lines—apparent because along them the herbage is darker—lines fairly direct yet sometimes wavering, here turned aside by a tussock of coarse grass, there by a tuft of bracken, crossing, merging, separating again. Any countryman will tell you, if you are town-bred and do not know, that these are the beaten tracks of the rabbits, the paths from burrow to food, each beaten down by the daily passing of the animals to and from their homes within the wood and their valley feeding grounds. In those tracks, in sheep and cattle tracks along the hillside, in the runways of the water-voles under the brambles and hedge trees that overhang the stream, you have pictured the early forms of the roads which have

from the most ancient of days to the era of the railways, been the most abiding indications of the necessity for human communication

It is in this kinship of necessity with the animals that the antiquity of the road lies embedded Hunger, the motive force of man, drove him to wander where he might find his food, and habit pinned him, once his tracks were made, to pass again and again along them Thus his tracks were beaten to thread or skirt the swamp, to follow the course of the river, to avoid or dare the spirit-haunted woods Far back in the mists of time we find the traces of the necessity which drove man, and still drives him, to be a road-maker, and thus we find the beginnings that have developed to-day into the railroad which has traversed desert and swamp, bridged the world's mightiest rivers, burrowed through mountain chains, linked up the threads of civilisation, and broken down the barriers of race.

The story of roads is the story of the progress of mankind The footworn paths of Neolithic man, the caravan routes of the desert, the roads of the Romans with their hurrying chariots and marching legions, the trade roads of the Middle Ages with their full and varied life, their merchants and men-at-arms, their pedlars, pilgrims, and friars, the coaching roads with the wealth spent on them in their later days to fit them for their fruitless competition with the rail—along them passed such a pageant of life as is nowhere else discoverable, the value of which was sufficiently indicated by Chaucer, who touched but the fringe of it

But reflect a moment more Through all the centuries of man's development, save the last, no advance had been made in the speed of communication beyond that of the quickest horse In this matter the Roman, the Arab, and the Tartar were the equals of the most cultivated and energetic races of the eighteenth century And then in a space of time that is but a breath in the history of man,

there is wrought a change so stupendous that few can appreciate to the full

It was with our Home Railways that this change began In this country it originated, though here we have no opportunity of seeing its larger developments We have here no thousand leagues of continents to cross, no ice-capped mountains to zigzag or to tunnel, but here were first dealt with the initial difficulties of the great expansion The difference is not in character but in degree, and the story of our railways is really in essence that of the world's greatest industrial enterprise

The story is worth telling because the time is opportune A hundred years ago we were just within the threshold of a revolution though we knew it not To-day we seem to be at the beginning of another era The flights of airships and aeroplanes suggest that these new machines are passing out of the stage of experiment into that of practical use

Moreover, we shall do well to read this story because we are all concerned with railways There is no one living in Great Britain who does not come into contact, somehow, somewhere, with the enormous power and organisation of our railways in the aggregate It is not too much to say that at present our whole system of commerce, and civilisation itself, stand or fall by railways By reason of railways London lives from hand to mouth, it is the railways that stand between London and starvation Famines have been averted, wars prolonged or ended by railways Every man of business knows that he is a cog in a vast mechanism of which the railways form an integral and vital part Imagine their withdrawal, and you are left with immediate chaos Concerning a force so potent in our national and business life it is surely wise and helpful that we should know far more than most of us do Here is a story which not only the grave and responsible business man should read, but also every youth entering for the first time the great world of business with hope and ambi-

tion in his heart Nor need he fear that this will be a task, rather will he find it as interesting as any romance

Yet once again the story is worth reading because it is by railways that those who live in great cities reach all that is beautiful and sacred in our Homeland To many, a railway journey is an infliction, this story should transform the experience into a delight Even if it has not that power, we must not forget, as we are swiftly borne from London to Cornwall, to Wales, to the Highlands, to the remotest ends of the mighty system that has its hundreds of terminals on the coast, in the heart of the hill ranges, far up tiny river-valleys, that it is this system that makes us free of the endless and varied beauties of our own country We too often affect a desire for places off the beaten track without thinking that but for the railways we should be as little likely to see them as were the town-dwellers of the Middle Ages

Were it not for the railways, the scenery and antiquities of our own land would be to most of us unknown For the ancient and beautiful things that the railways, or the consequent growth of towns, have swept away, they have atoned by putting us in touch with many more More beautiful lands there may be, but patriotism forbids us to admit it, and we are shameless in our love for these islands when we remember how many tongues have sung their charms, how every county is a repository of some typical natural beauty, and how every hamlet, town, or city is a storehouse of historical associations or the proud birthplace of some noble or faithful soul It is to a land of inexhaustible charm that our Home Railways have opened a thousand avenues of approach, and in this book you read the story of the work, and the fertility of resource of which we all, to-day and every day, in perfect assurance of safety and comfort, take advantage.

OUR HOME RAILWAYS

INTRODUCTORY

Richard Trevithick

"There be three things which make a nation prosperous, a fertile soil, busy workshops, and easy conveyance for men and commodities from one place to another" So wrote Francis Bacon four centuries ago The fertile soil this country had, the busy workshops had been given us by those who had put to use the mighty power of steam, and the easy conveyance came with the highest embodiment of that power, the locomotive, the thing that moves of itself, the most wonderful achievement of human ingenuity, for it is nearest to life

Heat may or may not be a mode of motion , but it is assuredly a cause of motion, and the commonest cause Far back in the development of mankind came the discovery and subjugation of fire, then came the water

boiling in the pot, and ages afterwards the bold adventurer who put the lid on the kettle and was the first to imprison steam, as he who invented the spout was the first to put steam under control Who they were no one knows, nor in most cases even in our own time does any one know the name of the real inventor The man who invents is not the man to talk and persuade, but to do. He is dumb; and many of the inventions made by the man are ascribed to the master who found the money to patent them with and the agents to introduce them And such is not the only sort of false representation in this connection, for the grim giant steam, as dumb as the inventor, did the work that was wanted and gave the nation the prosperity usually ascribed to the adoption of a theory of economics, and is doing it still wherever the theory is rejected

Railways have never been given the credit that is their due The majority who knew them in their infancy had little but evil to say of them That majority's children gave as cold a welcome to the bicycle, and we know how their children's children treat the motor-car. The railways had a harder fight than these to get a footing in the world, but they were here when we were born and seem as natural as the wind and tide

They were an invention, and there is no one more generally disliked than the inventor until after his death, when he gains nothing by his work, and then the community claim him as one of themselves and boast of what "we" have done He is the great disturber of capital, the encourager of the speculative, the introducer of new ways, the founder amid many failures of industries competing with industries that seem to have existed for ever, of trades taking the place of trades that are always at their best in the final stage of the contest that ends in their replacement It is easy to sneer at antiquity until we are reminded that we are doing as our ancestors did under

similar circumstances, and the opponents of railways are secure of at least a little sympathy as one result of that knowledge of the past required to realise what railways have done for us.

We are approaching a period of power when with electricity and internal combustion there promises to be no limit to speed, but steam raised the rate of movement to fivefold what it was a century ago "What is the use of all this hurry?" some will think it right to say, just as in those far-off days when man first made fire "What is the use of it?" was asked in the manner of the time The answer is—"Look around you! Where is the man that walks, except for exercise, when he can ride? Who rides in a slow train when he can travel in a fast one? Where is the man who will spend ten hours in a vehicle when he can find another that will take him the same distance in three?"

Speed? There is fascination about it that all feel, whether they admit it or not, for there is nothing in the animal world that would not go faster if it could Who without a thrill has seen the Cornishman sweep by on the way to the west—whizzing through the woodland, whirring down the slope, thundering over the bridge, booming through the cutting, humming along the level, burring on the bank, woods and slopes, tunnels and bridges, cuttings and banks, each with a note of its own?

The locomotive is the most interesting of machines for the same reason as the steam-hammer is the most popular of machine tools, there is no mistaking its purpose or the means by which it does its work And the story of our home railways, of which it is the central figure, is of more importance than that of any other industry Let us consider it again with the aid of new light from old and new sources that time has disclosed and trade caution no longer keeps back, though if ever there were a subject on which one has to go warily it is railway history, for

never was a path so strewn with misapprehensions and misprints

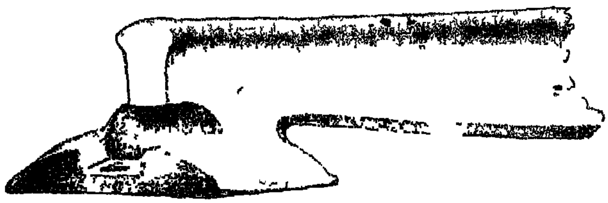
We all know what we mean by a railway, but it is as well to remember that the railway is essentially the road, the rail-way, on which the rolling stock is moved by men, horses, steam-engines, or whatever other engines may share it with them or replace them The railway began with the road, and it will end with the road.

The history of the road specially prepared for fast or heavy traffic would take us back a long way, let it be enough to note that on the 4th of August 1555 there was a tram from the west end of the Bridge Gate in Barnard Castle for the repairing of which Ambrose Middleton, in his will, left twenty shillings. The word tram seems to have been used in the north of England and south of Scotland as descriptive of the special track and the truck that ran on it The track was of timbers laid lengthways, the trucks were hauled by men or horses It was these railways with their rails of timber "exactly straight and parallel," running along the old wayleaves, that Roger North found in 1676, on which the "carts with four rowlets" carried the coals from the collieries to the Tyne

When these rails were first faced with iron we do not know, but in 1734 cast-iron wheels with an inner flange were in use near Bath, in 1767 Reynolds placed plates of iron on the old railway at Coalbrookdale with the flange inside, and in 1776 John Curr laid at the Nunnery Colliery near Sheffield a cast-iron plateway in which the iron was a right angle in section, the vertical of which was outside and kept the wheels on the horizontal track—an idea that caused a riot, the inventor having to remain in hiding for three days and nights in a neighbouring wood until the fury of the populace had abated

Thirteen years afterwards John Smeaton's pupil, William Jessop, improved upon this, at Smeaton's suggestion, by placing a narrow iron edge rail on his line

between Nanpantan and the Loughborough Canal and using inner-flanged wheels, thus removing the flange from the rail to the wheel and introducing into the world a railway about which there can be no dispute The rails were in yard lengths, about 40 lb to the yard, double-flanged in section, with a curved lower flange that spread out to form a foot, through which they were spiked down to cross sleepers What they were like any one can see by going to South Kensington, where, among the railway antiquities, "Cast Iron Edge Rails, M 2472," came from the original track which was of 4 ft 8½ in gauge They are rough and rusty, but there is thought in the old iron, do not pass them by with indifference

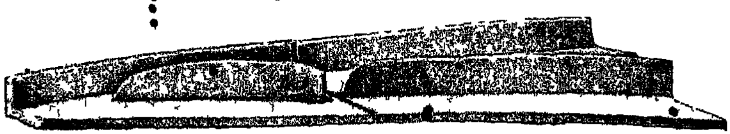


Jessop Rail (1789)

Rails were cast without the feet in 1797 in the Newcastle coalfield, they were placed on the so-called "chairs," and as the lines were braced with cross sleepers—apparently the "trams" or beams from which the name comes—the main features of the permanent way had been reached before the close of the eighteenth century. But nearly all the old tram-roads had flat rails, and among the most important of these in railway story were the Pollok and Govan, working in 1778, now part of the Caledonian, and that at Merthyr Tydvil—to the Glamorgan Canal, opened in 1794—which is now part of the Taff Vale

One other should be mentioned as a survival, the old lime line from Ticknall to the Ashby Canal constructed in 1799 by Benjamin Outram, who laid so many lines that the

word tram was said to have come from the last syllable of his name. But there were trams before there were Outrams, and the derivation is now only quoted as an aid to memory. This Ticknall tram-road with rails like Curr's was bought by the Midland in 1846. It has never been used, but in order to maintain their rights the company still run on it, once in the October of every year, a wagon loaded with coal solemnly drawn by a horse.



Outram's Ticknall Tram-rail (1799)

In 1799 it was proposed to lay a line from London to Portsmouth, and for the first portion of this the Surrey Iron Railway Company was formed, and obtained its Act of Parliament in 1801. This was the first railway company, the first public railway, and the first Railway Act so-called, though it was not the first Act in which a rail-way was authorised. The rails were 4 in. wide and 1 in. thick, with an arched flange ½ in. thick and 3½ in. high resting direct on stone-block sleepers. The gauge was 4 ft. 7 in. outside the flange; inside, as our present gauge is measured, it was about 4 ft. 6 in.; the four-wheeled wagons were 5 ft. wide, 2 ft. deep, and 8 ft. long, and they were worked by horses. The revenue was derived from tolls—there is one of the toll sheets at South Kensington—coals, for instance, being charged for at the rate of threepence per chaldron per mile. The first section of the line, opened on the 1st of June 1804, ran from Wandsworth to Croydon across Mitcham Common; the extension for which an Act was obtained in 1803, ran from Croydon to Merstham. This portion was taken over by the Brighton Company as their first purchase, and some of it forms part of their present system.

Between the Surrey's Act of 1801 and the Stockton & Darlington's in 1821, there were no fewer than nineteen Railway Acts, five of which were allowed to lapse Among the others there were, in 1802, the Carmarthenshire and the Sirhowy, now absorbed by the North Western, in 1804 the Oystermouth (Swansea to the Mumbles), which is still working independently, and is in that sense the oldest existing railway, in 1808 the Kilmarnock & Troon, now part of the Glasgow & South Western, in 1809 the Gloucester & Cheltenham, and the Forest of Dean, now included in the Midland and the Great Western, and in 1817 the Mansfield & Pinxton, now part of the Midland

Like their predecessors for fifty years or more, they were plateways rather than railways, and the men who laid them were the platelayers, whose name has ever since been applied to the layers and repairers of the track In several cases these old flat roads were the nuclei of later schemes, and, like the old Surrey, they can be traced in the sections which were abandoned They were there long before the coming of the steam-engine, and it was upon one of them that a locomotive made its first journey

At Redruth in 1797 lived two men to whom the world owes much William Murdock was in the house in Cross Street in which he invented gas lighting, and, within a stone's throw, at Moreton House, lived Richard Trevithick. Murdock had been in Cornwall for eighteen years as engineer to Boulton & Watt, and was to leave it in 1799 to be the superintendent of their works at Soho The two were opponents in business, Murdock being very much engaged in erecting Watt's engines and looking after Watt's interests, while "Captain Dick" was the most prominent of the Cornishmen who were using every endeavour to evade or improve upon Watt's patents

In 1759 John Robison, before he sailed for Quebec, was helping Watt to invent a locomotive, and Watt included the use of steam for land transport in his patents. But he

seems to have left the matter alone, and certainly discouraged any experiments about it among the staff of the Birmingham works Murdock, however, away at Redruth, had a freer hand, and took up this problem of making a wheeled carriage that would move of itself

One evening, wishing to put his model to the test, he went to the walk leading to Redruth church This was narrow, kept rolled like a garden walk, and bounded on each side by a high hedge It was dark and he was alone Lighting the lamp under the boiler he got up steam, and off started the locomotive with the inventor in chase of it Soon he heard shouts of terror Following up the machine he found that the cries proceeded from the parson who, going into the town on business, was met on the lonely road by the fiery little traveller According to the parson's daughter, her father and mother, returning from the town, were somewhat startled by a fizzing sound, and saw a little thing on the road moving in a zigzag way Murdock was with it, her parents knew him well They understood that he wished the experiment to be kept secret, and she did not recollect ever hearing of it afterwards Whichever story be accepted, it is clear that Murdock made a model, and that it moved of itself on Redruth church path.

He seems to have made two models at the least One, according to Wilson, reporting to the firm on the 9th of August 1786, had a 1½ in stroke, another, which is in the Birmingham Art Gallery, had a stroke of 2⅛ in; and about this, or a third one, there is a letter of importance among those now at Soho which cleared up the mystery why Murdock did not persevere with his work on the self-moving engine

Boulton, going into Cornwall, met a coach near Exeter in which he caught sight of Murdock. He got down at once, and Murdock also alighted According to Boulton they had a parley for some time "He said he was going to London to get men, but I soon found he was going there

with his steam carriage to show it and take out a patent, he having been told by Mr Wm Wilkinson what Sadler has said, and he has likewise read in the newspaper Symington's puff, which has rekindled all William's fire and impatience to make steam carriages However, I prevailed upon him to return to Cornwall by the next day's diligence, and he accordingly arrived here this day," 2nd of September 1786, " at noon, since which he hath unpacked his carriage and made it travel a mile or two in Rivers's great room, making it carry the fire-shovel, poker and tongs I think it fortunate that I met him, as I am persuaded I can cure him of the disorder or turn the evil to good At least I shall prevent a mischief that would have been the consequence of his journey to London" In short, Boulton & Watt had enough to do in their own line, and it did not suit them to lose Murdock or to launch out on to another that might be risky And so William Murdock, the most loyal of men, was deprived by the policy of the firm of the honour of introducing the locomotive

Murdock had ventured on high-pressure, and with high-pressure steam the Soho firm would have nothing to do But Richard Trevithick was a high-pressure man in several senses, and from his youth up had made it his peculiar study Naturally inventive, he was led on to invent a locomotive From the newspapers he may have heard of what Symington and others were busy at, or he may have been told, perhaps by Murdock himself, of what had occurred on the church path, at any rate eleven years after that he had a model ready

In 1797, when he was six-and-twenty, he had married and made his home at Moreton House, and here a few weeks afterwards the model was tried His friend Davies Giddy, in time Davies Gilbert, President of the Royal Society, had brought with him Lord and Lady De Dunstanville—De Dunstanville, before his peerage Francis Basset, being the great landowner of the district—and

Giddy was stoker, and Lady De Dunstanville was engineman and turned on the steam to the first high-pressure steam-engine

Shortly afterwards another model was made which ran round the table, or the room Its boiler and engine were in one piece, hot water was poured into the boiler, and a red-hot cast-iron block put into the oval flue, just like the hot iron in old-fashioned tea-urns It had a vertical double-acting cylinder, 1 55 in in diameter, and 3 6 in stroke, sunk in the boiler, and the piston rod ended in a guided crosshead, the connecting rods reaching down to crank pins in the two driving wheels which measured 4 in, and there was a fly-wheel driven by a spur-wheel on the crank shaft That model is now at South Kensington (M 1835), where it can be compared with a copy of Murdock's model (M 2413) which it in no way resembles

The model was experimented with and improved upon in many ways for some three years before Trevithick ventured on building a machine of full size While this was in hand he entered on an inquiry as to whether the wheels of a self-propelled carriage ought to be smooth or toothed, and he came to the conclusion that with smooth wheels it would have sufficient hold on any reasonable gradient To test this he hired the post-chaise that had been kept for Watt's use when he was at Redruth sixteen years before, and with Giddy he took this out on to a road near Camborne, and there, unharnessing the horse, these two men proceeded to work it uphill by applying their strength to the spokes of the wheels Several times on several slopes they moved it forward in this way, and in no case was there any slip The result confirmed his expectation that the wheels might have smooth tyres but to guard his rights, in the patent of 1802 he expresses himself—"We do occasionally, or in certain cases, make the external periphery of the wheels uneven, by projecting heads of nails or bolts, or cross-grooves, or fittings to

railroads when required, and in cases of hard pull we cause a lever, bolt, or claw, to project through the rim of one or both of the said wheels, so as to take hold of the ground, but in general the ordinary structure or figure of the external surface of these wheels will be found to answer the intended purpose"

On Christmas Eve 1801 the engine was ready, and the first load of passengers was moved by steam on what is known in the neighbourhood as "Captain Dick's Puffer" The rain was coming down heavily, the road in places was rough with loose stones, and the gradient such that the wise cyclist walks his machine up, but "she went off like a little bird" for three-quarters of a mile up Beacon Hill at what is now Camborne railway station and home again Over their Christmas dinner Trevithick and his cousin Andrew Vivian became partners, and they were soon in London armed with letters of introduction from Giddy to Humphry Davy, who introduced them to Rumford, both of whom helped them in securing their patent

On the 22nd of August 1802 Trevithick was at Coalbrookdale erecting a pumping engine, and wrote from there to Giddy, "The Dale Company have begun a carriage at their own cost for the railroads, and are forcing it with all expedition," but of this little further is known Later in the year he was in Cornwall building another locomotive which he brought with him to London in 1803, where he learnt from the varieties of paving that such machines would be more efficient on a smooth iron road And in October he was at the Penydaren Ironworks, near Merthyr Tydvil, building the engine with which the railway era is frequently said to begin

This was designed for many uses and worked on the tram-road for the first time on Monday the 13th of February 1804 "It worked very well and ran up hill and down hill with great ease, and was very manageable We had plenty of steam and power," wrote Trevithick to his

friend Giddy, and on the following Monday he wrote, "The engine, with water included, is about five tons It runs up the tramroad of two inches in a yard"—twice as steep as Bromsgrove Lickey—"forty strokes per minute with the empty wagons The engine moves forward nine feet at every stroke The steam that is discharged from the engine is turned up the chimney about 3 feet above the fire, and when the engine works forty strokes per minute, 4½ feet stroke, 8¼ inches diameter of cylinder, not the smallest particle of steam appears out of the top of the chimney, though it is but 8 feet above where the steam is delivered into it, neither at a distance from it is steam or water found The fire burns much better when the steam goes up the chimney than when the engine is idle I intend to make a smaller engine for the road, as this has much more power than is wanted here This engine is to work a hammer We shall continue our journey on the road to-day with the engine until we meet Mr Homfray and the London engineer, and intend to take the horses out of the coach and draw them home The coach axles are the same length as the engine axles so the coach will run very easily on the tramroad"

The London engineer had been sent down by the Government with a view to ordering similar engines if this one passed certain tests, these being—"The wagon engine is to lift the water in the pipes, then go by itself from the pump and work a hammer, then wind coal, and lastly to go the journey on the road with a load of iron!"

On the Tuesday the great run took place from the works to the Navigation House "Yesterday," wrote Trevithick to Giddy, "we proceeded on our journey with the engine, we carried 10 tons of iron, five wagons, and seventy men riding on them the whole of the journey It is above nine miles, which we performed in four hours and five minutes The engine, while working, went nearly five miles per hour, no water was put into the boiler

from the time we started until we arrived at our journey's end. The coal consumed was 2 cwt On our return home, about four miles from the shipping place of the iron, one of the small bolts that fastened the axle to the boiler broke, and all the water ran out of the boiler, which prevented the return of the engine until this evening"

The engine continued working, and ten days afterwards was tried with 25 tons of iron "We were more than a match for that weight," writes Trevithick to Giddy, and continues, "the steam is delivered into the chimney above the damper, when the damper is shut the steam makes its appearance at the top of the chimney, but when open none can be seen It makes the draught much stronger by going up the chimney, no flame appears" On the 10th of July we have Homfray writing to Giddy, "Trevithick went down the tramroad twice since you left us, with 10 tons each time," so that it must have been kept on duty for some months before it was withdrawn to work the rolling mill William Richards was its first driver, and he drove no other engine all his life though he was engine-driving at Penydaren until he was over eighty So far from Trevithick's engine being broken up, it was kept in repair as long as the ironworks lasted, and then little was left of what it was originally built of Very different all this from the usual story! But the first engine that ran on an iron road is of too much importance for legends about it to be repeated when the truth is known.

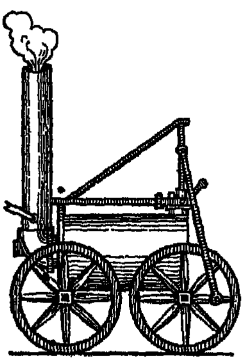
During the rest of the year Trevithick was busy about the country superintending the erection of his high-pressure stationary engines In September he was at Newcastle arranging with Christopher Blackett, the owner of *The Globe* newspaper, to supply him with a locomotive for Wylam Colliery This was erected at John Whinfield's works at Gateshead, and was completed in May 1805 The working drawings are at South Kensington (M 1310) Like the Penydaren engine, on which she was an improve-

ment, she had no bellows draught, Trevithick having abandoned it as soon as he found the steam-blast sufficient The statement, and the argument built on it, that in 1815 he proposed to use vanners, must be due to some one who never read the specification (No 3922), which is not for a locomotive but for quite a new kind of stationary engine in which the steam acted as a cushion on the water and was used over again instead of being allowed to escape

This Gateshead engine was the first with flanged wheels, but these did not suit the Wylam track which then had wooden rails Three years afterwards these were replaced with the cast-iron rails on which, in 1813, Puffing Billy had an easier task And so she was taken off and used for many years as a stationary engine On a temporary iron railway in Whitfield's yard she had worked satisfactorily, being the first engine to work on an iron edge rail Every one in the district interested in engineering went to see her, and with her the history of the locomotive begins in the north

During the next ten years several other engines were built by Trevithick, who was a man of many inventions For some years he was busy with a steam dredger for the Thames and his iron tanks for water cisterns He was the engineer of the first Thames Tunnel, that of 1809, two years afterwards he built the first steam threshing machine, for Hawkins, and followed this by the steam plough In 1812 came the Cornish pumping engine as we know it, and in 1815 his screw propeller for steamships for which he proposed a boiler with small tubes through which went the water, not the fire, being, in fact, the first water-tube boiler, foreshadowed in his locomotive boiler

In 1808 he was in London running his Catch-me-who-can at twelve miles and more an hour on his circular iron road where Torrington Square now is, hauling on the track an open carriage—as he had done Homfray's—in which were passengers at a shilling a head, being in fact


The first Passenger Engine (1808) (From Trevithick's Visiting Card)

the first passenger engine The track was on longitudinal sleepers, and the engine weighed over eight tons and was more like a modern locomotive than the Gateshead one, for he had abandoned the cog-wheels and also the fly-wheel which still survives on our traction engines and steam rollers

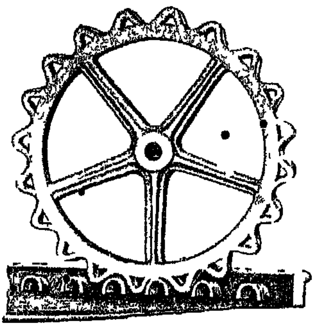
During 1814 he became connected with a scheme for working certain mines in Peru in the Cornish manner, and he built at Hayle nine of his pumping engines which were shipped for Lima, three of his friends going out with them Their reports were so favourable that in October 1816 he left for the land of promise, and for seven years he prospered so that he became worth nearly half a million of money, and then the War of Independence broke out by which he was ruined, the natives, looking upon him as a Spanish emissary, blowing up his engine-houses and throwing the machinery down the shafts With difficulty he escaped with his life, and had to make his way northwards through the forests alone into Costa Rica, where he conceived a scheme for a railway across the isthmus

In 1805 and thereabouts he had been frequently on Tyneside among the enginemen and others Twenty-two years afterwards, when upset at the mouth of the Magdalena, he was lassoed from drowning—and an alligator—by Bruce Hall, who took him to Robert Stephenson at Cartagena "Is that Bobby?" asked Trevithick "I have nursed him many a time!" And so he had He and Robert Stephenson left South America together, one full of his project for running a railway from the Atlantic to the Pacific the other to help on the Liverpool & Manchester

When George Stephenson made Trevithick's acquaint-

ance he had just moved to the West Moor Pit at Killingworth as brakesman. His struggle upward from herding cows at twopence a day had been long and was not over. It is easy to give the years, reeling them off one after the other, and forget that each consisted of twelve months; and it was more than two hundred and fifty months before he began to earn £2 a week. He is credited with more than his due, for in the days when the opposition to railways was at its fiercest it was necessary for parliamentary and advertising purposes to magnify his reputation as an authority on every branch of engineering. He was not the "father of the railway engine"—that honour is Richard Trevithick's—nor was he "the inventor of railways." But his knowledge of the whole matter, derived from the machines and the men who made them, was immense; and his organising powers remarkable. He was in the front all through the fight against the old order of things, the one conspicuous figure to whom the railwaymen looked for leadership; around him the storm centred; and it is to him more than any man that we owe our railway system.

In 1811 John Blenkinsop patented (No. 3431) a rail with "a toothed rack or longitudinal piece of cast iron or other fit material having the teeth or protuberances or other parts of the nature of teeth standing either upwards, downwards or sideways" with the intervals of which "a wheel having teeth or protuberances" would engage; and thus he became the originator of our mountain-climbing railways. He was the agent of the Middleton Colliery, and to carry the coals down into Leeds, three and a half miles away, he hit upon this contrivance and laid out the road on which the levels were few and the gradients many. As shown by the Museum specimens (M. 2325) he did not use a rack but "protuberances," as he called them, these being a series of almost semicircular ears arranged along the side of the rail half an inch from the upper edge like so many small arches, each about 3 in. across, $\frac{3}{8}$ in. thick,



Blenkinsop Wheel

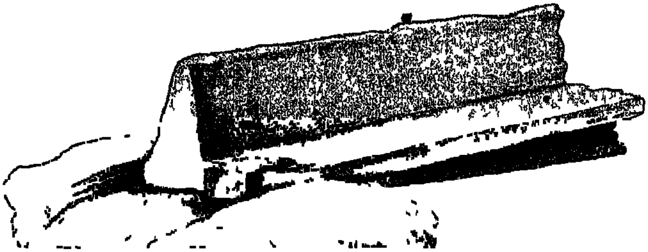
and projecting some 2¼ in There were seven of these ears to each rail, which was 41 in long The top of the rail was smooth and the carrying wheels of the engine were smooth The driving wheel between them worked outside the rail, not on it, its projections being rounded so as to run easily between the rounded ears

Blenkinsop patented the principle of the rack and wheel, not the engine or "carriage" as he called it The engines he used were designed and built by Matthew Murray, and had two cylinders, as

Blenkinsop Rail and Chair (1811)

recommended by Trevithick in his patent of 1802, so arranged that the cranks were at right angles to each other, thus getting over the difficulty of starting. They were the first engines with two cylinders, the first with six wheels — 2-2-2 in fact — and the railway was the first that was financially successful The first engine made its first run from the colliery to the wharf at Leeds on the 24th of June 1812, its load at the finish being eight wagons carrying twenty-five tons of coal and fifty people In regular work the trains were composed of as many as thirty wagons, and considering the gradients and the weight of the engine, which was only five tons, Blenkinsop was probably correct in thinking he could not do without his protuberances

In 1812 Stephenson was appointed engine-wright at Killingworth High Pit at a salary of £100 a year, and in riding about inspecting the collieries belonging to the same owners and others he became interested in the new railway between the Kenton and Coxlodge collieries and the Tyne. This had the Blenkinsop rail and engines. Next year, at Mr Blackett's suggestion, William Hedley, who had found by an experiment confirming Trevithick's experience that smooth wheels had sufficient adhesion on smooth rails for the gradients on the Wylam track, built Puffing Billy.



Wylam Rail (1808)

At first this, like his experimental engine of 1811, which was a failure, had four wheels, but as it broke down the cast-iron plate track, it was in 1815 made an eight-wheeler, each group of four wheels being carried on a sort of bogie. In 1830 the line was relaid with cast-iron edge rails, and then Billy was altered and became a four-wheeler again. This engine from the first was a great improvement on the horses, and was actually kept at work until 1862; it is now at South Kensington. The sister engine, Wylam Dilly, which worked on until 1867, is in the Edinburgh Museum.

Stephenson carefully watched them working on the road that ran past the cottage in which he was born in 1781, and came to the conclusion he could improve upon them as well as on the Coxlodge engines, and in 1814 he built Blucher, his first locomotive. To begin with, this was rather a failure, but as soon as he turned the waste steam into the

funnel as Trevithick had done he doubled the power and made it a success, thus leading on to his Killingworth engine of 1815 At first this had coupling-rods placed upon inside cranks between the wheels, but owing to one of the crank axles getting bent he replaced the rods with the chain gearing familiar to us in the bicycle

The same chain-coupling with the sprocket wheels was used in his engine of 1816 In 1817 the Duke of Portland ordered one of these engines for his Kilmarnock & Troon line, the first locomotive to be worked in Scotland, but the cast-iron wheels damaged the cast-iron track and were ingeniously replaced by wooden ones

Some of the Scottish tram-roads are very early in date When Johnnie Cope fought the battle of Prestonpans he placed his artillery on the tram-road from Tranent to Cockenzie , the Carron Ironworks put down lines soon after their opening in 1760 , most of the collieries in Midlothian, Fife, Lanark, and Ayrshire had their iron roads , and in 1810 matters were so far advanced that Telford surveyed the route of a railway from Glasgow to Berwick In the south steam traction did not progress very much, but it did not die out All along a few Trevithick engines appear to have been working in South Wales , and in 1814 William Stewart built a locomotive for the Park End Colliery in Gloucestershire, which was tried on the Lydney line, now the joint property of the Midland and Great Western

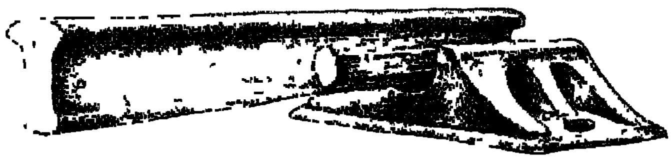
The engines were waiting for the roads to be strong enough to carry them Cast-iron rails continued to be used owing to their cheapness, but rails had here and there been made of wrought iron for some years When Timothy Hackworth went to Walbottle Colliery as foreman of the smiths he found rails of malleable iron which had been laid by Nixon in 1805 , and in 1808 wrought-iron rails were in use on the Tindale Fell line, a specimen of which, merely a square bar spiked to stone blocks, is at South Kensington (M 2487) Then in 1820 came John Birkinshaw (No 4503)

to do with his mill for the rail what Henry Maudslay did with his slide-rest for the engine cylinder To quote Thomas Baker, the poet of the "Steam Engine"—

> "By rolling-mill he these tough rails produced,
> And these, without improvement, still are used,
> No hammer work, unseemly weld, or flaw
> Was in the work of famous Birkinshaw!"

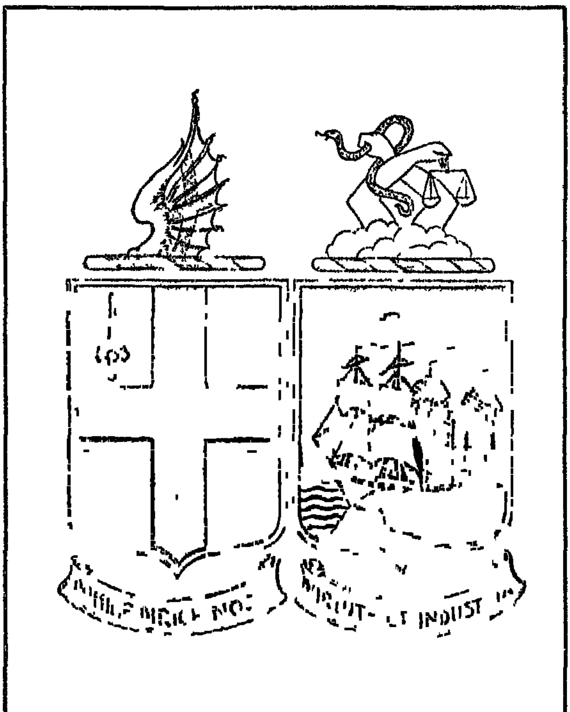
But enough of these old roads The year the first engine went to Scotland a railway was projected from Darlington to Stockton-on-Tees By it was the experience gained on the colliery lines to be utilised for the public benefit, with it the railway age, as most people know it, really opened How it rapidly developed under Stephenson's influence from a railroad to be worked by horses into one worked by steam, and led to all being worked by steam, we shall see in the story of the North Eastern

The order in which our home railways should be dealt with we will leave for others to discuss If we were to choose the oldest, and reckon the age from the earliest line it absorbed, we should probably begin with the Caledonian If we were to arrange them according to their present position the task would be more difficult, for the Midland has the largest capital and the largest stock of carriages and trucks, the North Western takes the most money and has the greatest number of engines, the Great Eastern carries the most passengers, the North Eastern carries the most minerals and the most merchandise, and the Great Western is by far the longest and its trains travel the most miles. Let us follow Bradshaw and begin with the Great Western, which is the oldest of the great companies bearing the original name.

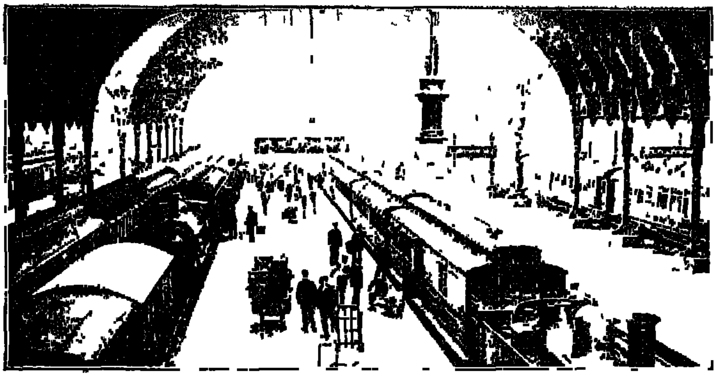


Birkinshaw Rail and Chair (1820)

THE GREAT WESTERN



CRESTS &
COATS-OF-ARMS



Paddington Station

THE GREAT WESTERN

A Great Western Guard

THE Great Western will take you to Fishguard—the nearest railway port in Britain to New York—and so to Ireland by the shortest sea passage, unless you care to go as far northward as Stranraer, it will take you to Plymouth, where other ocean liners come, and to Weymouth and through to the Channel Islands From Weymouth to Fishguard—with Bridport, Dawlish, Teignmouth Torquay, Brixham, Kingswear, Kingsbridge, Fowey, Falmouth, the Lizard and Penzance on the Channel coast, St Ives, Newquay, and Barnstaple on the Atlantic, Minehead, Watchet, Weston, Clevedon, Bristol, Newport, Cardiff, Swansea and Tenby, and the rest, on the Bristol

Channel—it has more ports and seaside places on its list than any other line. Northwards, on what is roughly a triangle, with Didcot and Newport as its base and Chester as its apex, its branch lines cross and recross in profusion; and though its longest run from London is some 305 miles, yet so many are its branches and cross-routes that its mileage, to say nothing of its motor-car work, is more than nine times as great, being 900 miles more than that of any other English company, and an eighth of the total mileage of all the railways in this island.

What with its buffet cars, breakfast cars, luncheon cars, dinner cars and sleeper cars, a journey in its trains is almost as independent of distance as a voyage in a steamship. To show what it can do it has run a train from Paddington to Plymouth at an average rate of over 63 miles an hour, the average all the way down to Exeter being over 67, and in ordinary working it runs without a stop to Plymouth in a few minutes over four hours.

One of the Vans of the Ocean Mail Special

We hear of ocean mails being handed over at Paddington four and a half hours after the steamer entered Plymouth Sound; of the King's garden-party with 4000 guests in eleven first-class trains to Windsor and back being managed on the same afternoon as the Windsor race traffic; and of the biggest annual excursion, that from Swindon, in which twenty-two trains carry 25,500 passengers, the largest item in the hundred million passengers it carries in a year.

Its original directors wished it to be a line on the cheap;

1—C 22

THE GREAT BEAR

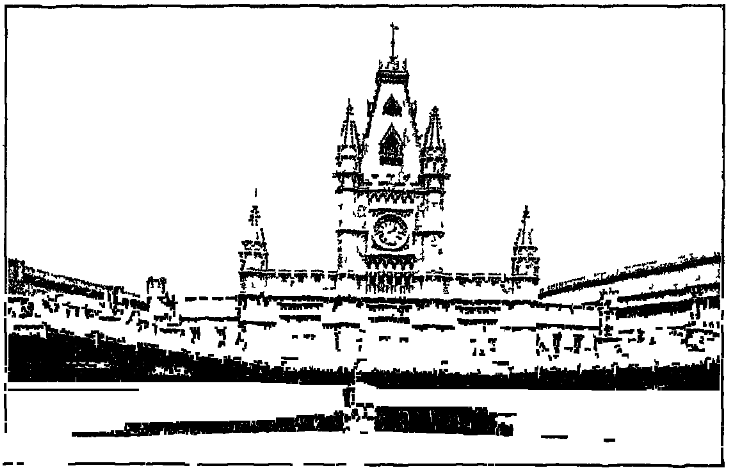
but the man who made it was in advance of his time, the very last to be influenced by the lowest tender "Speed" was his motto, and everything else of the best regardless of expense The road was wide, and the purse was deep, and the calls on the purse were frequent and great Never was there a line that did more fighting in its infancy or woke up others more But it woke them up to excel it, until after a long interval it adopted their methods and regained its position of second to none

Many have sung the praises of the broad gauge and told of its smoothness of movement—which has long since been surpassed by the corridor cars on the same route, its speed, which is equalled over much longer distances with much heavier trains by its present engines, and many other things in its favour, yet there is another side to the story In the old days the way to the west was the best of travelling for those in the first class, of which we hear so much, but in the third class, narrow cupboards with seven a side and little room for the knees, it was not so pleasant, particularly for the man in the middle, occupying, according to Brunel, the safest seat in the carriage, who would gladly have sacrificed some of the smoothness for more of the view Good old broad gauge! Let us speak the best of it and say little of its faults, as is generally done, but really what the Great Western did with it they are doing better with the narrow, and they will do better yet, for there is no more progressive company

Bristol the Great Western began with, and Bristol is its centre still If any one doubts this let him draw a map of the system, with its many spurs and interlacements, from Manchester to Weymouth, from London to Fishguard and Penzance He will wonder how such a maze, with its eighty terminal stations, has come about, and he may be surprised to find that it owes its origin to the difficulty of navigating the Upper Thames

In the old canal days the barges carried the goods on

the river between London and Reading, where they entered the string of canals which took them to Bath and on by the Avon to Bristol, and what with the few locks and the many shoals, the droughts and the floods, they were often three weeks, and sometimes six, on their journey With their goods on the road as long as they are now between London and the Cape, and matters getting worse, it is not to be wondered at that the Bristol people began to think of having a railway at both ends, where the main trouble seemed to be, and in 1824 one was proposed from Bristol to Bath, and next year one from Reading to London, the idea being to trust to the barges over the rest of the route



Temple Meads Station, Bristol The centre of the Great Western system

That year, however, Francis Fortune came out with his General Junction Railroad from London to Bristol and elsewhere, and there being two plans for the Bristol folks to think over they did nothing

For seven years more the barges continued their leisurely and adventurous voyages on the Thames, and then a series of wrecks and delays—and the success of the Liverpool & Manchester revived the railway project The Bristol

citizens resolved to have a line of their own which went all the way, "The Bristol & London Railway," so in 1832 they held a town's meeting and appointed a provisional committee who early in the following year advertised for an engineer One of the answers to that advertisement was from Isambard Kingdom Brunel, and he was the selected candidate

Brunel was not unknown in Bristol Born in 1806, the son of Sir Marc Brunel who made the Thames Tunnel and did many other notable things, he was well educated, and specially trained in England and France for civil engineering He began work in his father's office when he was seventeen, and soon became resident engineer at the tunnel When he was twenty-three he sent in plans in a competition for a suspension bridge over the Avon at Clifton, which were rejected at Telford's recommendation Two years afterwards, in competition with Telford, he sent in other plans which were submitted to a referee, the then President of the Royal Society, Davies Gilbert, formerly Giddy—the friend of Trevithick—who was to prove as true a friend of Brunel The design was accepted, and the work begun, but it was thirty years before it was finished

In 1841 Brunel designed the Hungerford Bridge over the Thames on the same principle, which lasted until 1860, when it was removed to make way for the Charing Cross railway bridge, and then certain leading engineers, who "had an interest in the work as completing a monument to their late friend Brunel," bought the materials and with them, in 1864, completed the bridge that so gracefully spans the gorge of the Avon between Leigh Woods and Clifton Down

In 1831 Brunel was busy planning and building docks at Monkwearmouth, Milford Haven, Bristol, and elsewhere, in fact he was becoming known as a dock engineer Next year, however, he took to railway work, the branch of his

profession with the most promising future, and was engaged "to make a survey for a cheap line between Birmingham and Gloucester," which he did by going east of Bromsgrove Lickey to secure a gradient of not over 1 in 300

It was while this Birmingham & Gloucester matter was being discussed that Brunel, on the 7th of March 1833, was appointed engineer of the Bristol company With his usual energy he set out surveying at once The line to London had to touch at Bath and Reading, otherwise he had a free hand, and the whole country was open before him Between Bristol and Bath he could not go far wrong, between Reading and London he had the valley of the Thames, and went the obvious way, but between Bath and Reading he had full scope for his judgment, and the route he chose by Swindon and Didcot could not have been better

The Bill was introduced in March 1834 "to construct a railway from London to Reading, and from Bath to Bristol, as a means of facilitating the ultimate establishment of a railway between London and Bristol" The title Bristol & London had been dropped on the 19th of August 1833, though the arms of those cities were retained, and, probably at the suggestion of Gibbs the banker, the line had become the Great Western With the barges in view as feeders to the railway, Brunel placed his London terminus on the river-bank at Vauxhall, then he shifted it to what is now Grosvenor Road, on the opposite bank, then, owing to the strenuous opposition, he placed it where South Kensington Station now is, but all to no avail, and the Bill was thrown out by the Lords Next year it was introduced with the line ending in a junction with the London & Birmingham at Kensal Green, Euston to be a joint station, and it passed In the following year, 1836, another Act placed the Great Western terminus in a certain field at Paddington, where the present station was opened in 1854

In the first Bill the gauge was mentioned as being 4 ft. 8½ in' In the second there was no mention of the gauge,

1—04

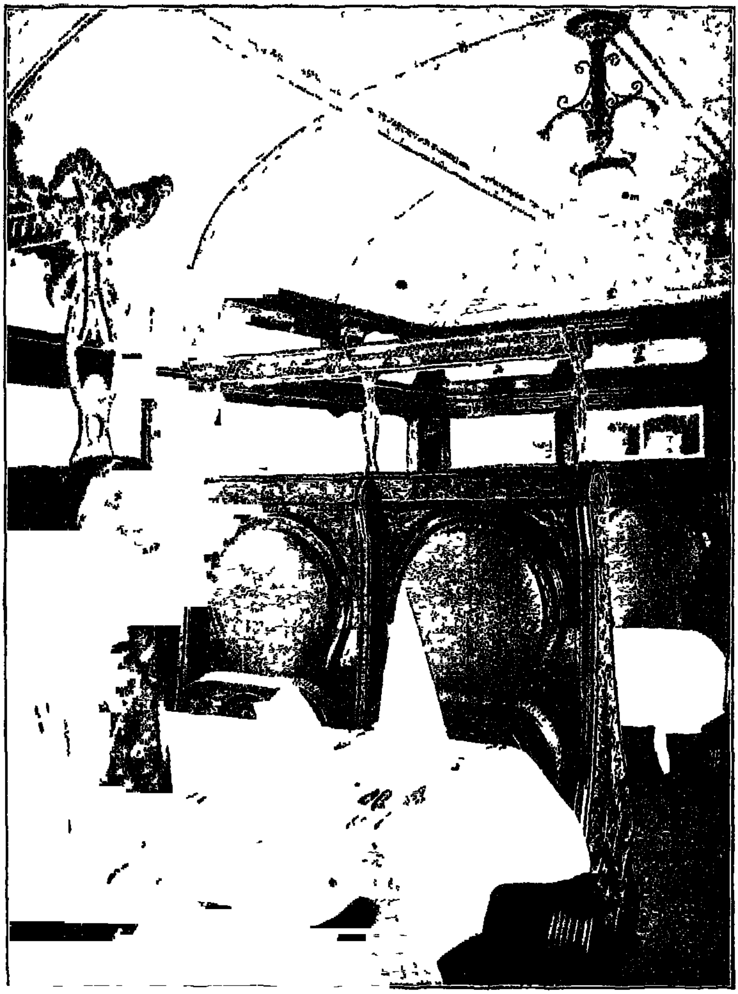
A 100 WAGON COAL TRAIN

and the omission remained unnoticed while it was passing through Parliament Thus the company were left to adopt any gauge they pleased The reason was that Brunel had persuaded himself that the existing gauge was too narrow

When the first trucks began to run on the Stockton & Darlington, Nicholas Wood saw that quite a new sort of vehicle was required for railway work, and he designed it, the principle being that the body, instead of being hung between large wheels, should be of full width and overhang small wheels Brunel thought the new vehicles ugly and unsafe, and proposed to take the same width of body as Wood and hang it between the wheels again thus increasing the length of the axle-trees This meant that the gauge should be something approaching 7 ft , and he made it 7 ft Just one carriage was built on this plan, and the waste of space was so evident that the directors ordered the carriage bodies to be made of the full width so as to overhang the wheels, as on other lines, and carry as many passengers as possible With the building of the second carriage the argument for the broad gauge really collapsed , but Brunel, with wonderful ingenuity, set himself to prove that 7 ft was the best of all possible gauges, as on the same method he could have proved 6 ft or even 10 ft to be

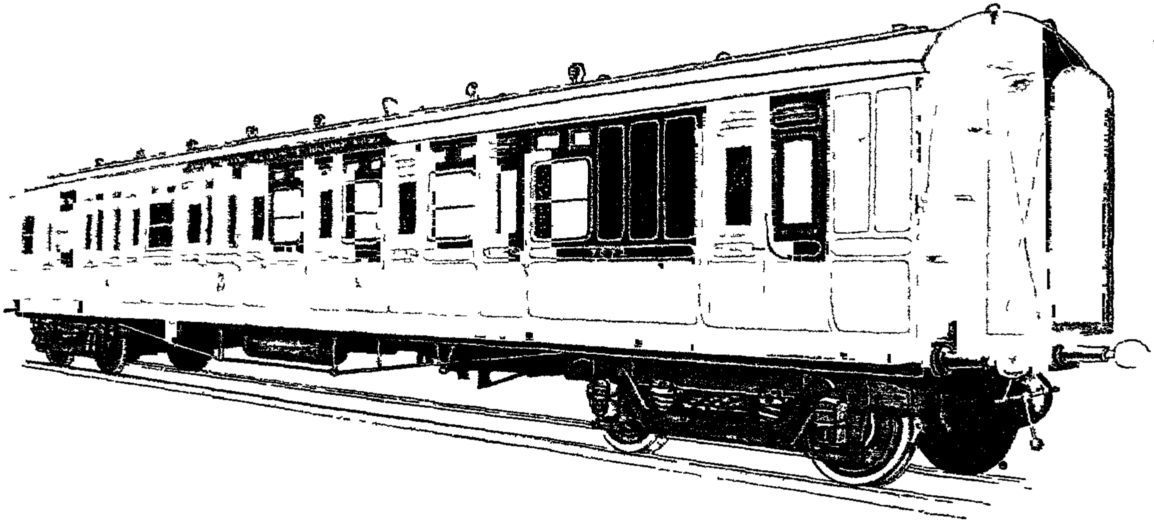
There was another reason for this difference of gauge By having a special gauge Brunel hoped to keep the west and south-west of England as the special territory of the Great Western, as it would have done for a time, but, so soon as the directors resolved to extend the line northwards, that argument also collapsed George Stephenson saw much farther ahead when it was proposed to have a special gauge for the Leicester & Swannington—" I tell you the Stockton & Darlington, the Liverpool & Manchester, the Canterbury & Whitstable, and the Leicester & Swannington must all be 4 ft 8½ in Make them of the same width , though they may be a long way apart now, depend upon it they will be joined together some day "

It was left for a Great Western man to point out that the gauge of the stone tramways of Pompeii, as measured



First-class Dining Saloon

by W H Mills, was 4 ft 11 in, or a little less, as shown by the ruts in them, and it is probable that the chariots were



THE GREAT WESTERN RAILWAY

COMPOSITE BRAKE CORRIDOR CARRIAGE No 7672

Extreme length 70 0′ Length on wheel base, 63 6″ Extreme width, 9 0′ Extreme height from rail 12 6½

Seating capacity { First Class	12	Total weight	2 tons 15 cwt	Steam warmed
Third	48	Lighted by gas	Two lavatories	Vacuum brake

of similar gauge that ran on the Roman roads of Britain, the width of which roads would fix the width of the country roads and the gauge of the vehicles when they were introduced The old tram-lines were made to take the local carts and wagons, and the gauge that suited them was 4 ft 8 in or thereabouts between the guards Hence Jessop laid his edge-rails of 4 ft 8½ in gauge to take the place of the guard-rails so that carts could run on them, by merely substituting flanged tyres for flat ones When the Stockton & Darlington was first planned the endeavour to accommodate miscellaneous traffic was kept in view, and hence the gauge was made the same as Jessop's, and, in order that the engines and carriages might be interchangeable and the same patterns used at the engine factories, the Liverpool & Manchester and its connections adopted the same gauge

When the broad gauge met the narrow gauge the trouble began The Bristol & Gloucester, laid out as a narrow-gauge line, fell into financial difficulties before it was finished, and came under the management of the Great Western in 1844, and Brunel promptly made it broad-gauge Next year the Great Western succeeded in obtaining an Act authorising them to run a broad-gauge line from Oxford through Worcester to Wolverhampton, and the decision of Parliament led to so much discontent that a Royal Commission was instructed to inquire into the gauge question They reported in 1846 that so far as the safety, accommodation, and convenience of the passengers were concerned, one gauge was as good as another, that in respect of speed the broad gauge had the advantage, that so far as goods were concerned the narrow gauge was more convenient, and more suited to the general traffic of the country, that the broad gauge involved the greater outlay, and that as they had not been able to discover, either in the maintenance of the way, or in the cost of locomotive power, or in the other annual expenses, any adequate reduction to compensate for the additional first cost, they

recommended that 4 ft 8½ in be declared by the Legislature to be the gauge used in all public railways constructed in Great Britain And so the loosely-drawn Gauge Act was passed that year, enacting that no more broad-gauge lines should be made

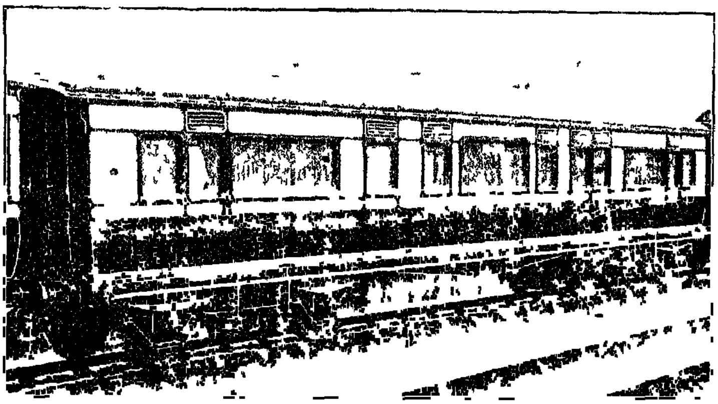
In spite of this the Great Western went on with the broad road that led to less dividends, and in 1847 brought in a Bill for a broad-gauge line from Oxford to Birmingham This was referred to the Railway Commissioners of the Board of Trade, who adopted a compromise suggested by Brunel that broad-gauge lines should be allowed, provided that a narrow-gauge track was laid as well, in other words that the mixed gauge should be introduced, consisting of three rails instead of two, with one rail doing double duty

Thus the mixed gauge came in with the Oxford & Birmingham, but Brunel went on building broad-gauge branch lines, and only put down the extra rail where the traffic from the northern or south-western lines rendered this a cheaper way of getting over break of gauge than transhipment And the broad-gauge trains went as far north as Wolverhampton, as far west as Penzance In London, by way of Kensington, they ran into Victoria, of which the Great Western still holds the joint lease with the Chatham & Dover, whence its name appearing on the front of the new S E & C R Station, and by way of Bishop's Road they ran into Farringdon Street

But the three-rail system, with its complicated points and sundries, proved expensive and unsatisfactory, and in 1868 the defiance of the inevitable came to an end The conversion of the road followed the conversion of the directorate The first line to be converted from the broad gauge to the narrow was that from Prince's Risborough to Tring, next year the narrow gauge was substituted on the lines from Grange Court to Hereford, from Oxford to Wolverhampton, from Reading to Basingstoke Next year the narrow gauge was put down between

Maidenhead and Oxford, and so the conversion extended until in 1892 the broad gauge was quite cleared away. And with its disappearance the company began to thrive as it had never done before.

Brunel's error lay in assuming that with the introduction of steam an entirely fresh start could be made instead of



The Royal Saloon

a development. The wider gauge—as he found when, three years after he had started on the Great Western, he made the narrow-gauge Taff Vale and took in the Penydaren line—would have rendered it impossible to utilise the old tram-roads without Acts of Parliament to widen them, and the error was all the more noteworthy from the fact that the first railway he was employed on was but an extension of the old Gloucester & Cheltenham tram-road with which he began his surveys. Nothing is more remarkable in railway story that in the battle of the gauges, which he provoked, the decisive encounter should have been between his first line and the one he brought to it, for Gloucester proved to be the key of the position.

Here not only did all change but everything changed. The broad wagons coming up from the south had to be unloaded into the narrow wagons for the north,

and the goods from up Birmingham way had to be transferred into the larger broad wagons Confusion reigned supreme Every truck took on an average an hour to empty and an hour to pack, to say nothing of the damage caused by handling and the expense of delay Anything that went wrong was always "lost at Gloucester". All sorts of devices were tried to improve matters, but in vain, owing to the trucks being of different sizes and the men taking sides as if the transhipment were a football match or an incident in a civil war It soon became clear that either the narrow gauge must get to Bristol or the broad into Birmingham, and this resolved itself into whether the Bristol & Gloucester should be controlled by the Midland or the Great Western The Great Western were in possession, they were managing the line and were large shareholders, and considered they had a prior claim, but on the critical day Mr Ellis of the Midland offered a six per cent guaranteed dividend on the stock, while Mr Saunders of the Great Western only offered share capital, and he lost the bargain Thus the northern advance of the broad gauge was stopped in the west and the narrow gauge went into Bristol

Brunel in those experimental days made another expensive mistake—it cost nearly £100,000—in endeavouring to do something new The older tram-roads were of wood laid on cross sleepers, on the wood the iron was placed, until in time the iron was made strong enough to be laid on the sleepers without intermediate support Brunel, following Trevithick at Torrington Square and Robert Stephenson in the mile of line through Glenfield tunnel, put his rails on longitudinal sleepers, bracing them together with cross-ties or transoms, but he made matters worse by resting the joints of the sleepers on piles driven from 7 to 10 ft deep The top of the sleepers he adzed or planed down to one uniform surface, on which he placed a plank of hard wood sloping

inwards at an angle This hard-wood plank he laid on with a thick bed of tar and nailed down with two long nails, the nails being driven in two rows on each sleeper so as not to interfere with the bolts, the heads of the nails being punched in so that the wood could be planed and then he tarred the surfaces of all the joints and butts, and the whole of the bottom and sides of the sleepers and all the ironwork The rails, which were of what is known as the bridge section with a slight bevel inwards, were fastened down by screw bolts, a piece of felt being placed between their base and the wood, the outside screws having square heads, the heads of the inside ones being countersunk on account of the flange of the wheel The outside screw was driven until the rail fitted close down, the inner one was then screwed tight, and a very heavy roller was passed two or three times along the rails and the screws tightened up wherever possible In fact a beautiful, well built, rigid road

But it was too rigid There was no spring between sleeper and sleeper to give the wheels a firmer grip and help the train to climb a gradient, though it would have done well on the level if it had not been for the piles, on which a little wet weather left the sleepers hanging On the Manchester & Leeds in 1839 a part of the line through a rock cutting had the chairs spiked directly down to the native rock, and people expected they would last for ever, but they were all taken up in three weeks, as unless the train slowed to some four miles an hour rails and springs were broken wholesale Jesse Hartley, in a search for rigidity, bolted his rails down on to parallel walls of granite, but rails, tyres, and springs broken daily soon convinced him of the error of his ways This pile arrangement of Brunel's was almost as bad, and every pile along the twenty-three miles between Paddington and Maidenhead had to be pulled up or driven down out of harm's way

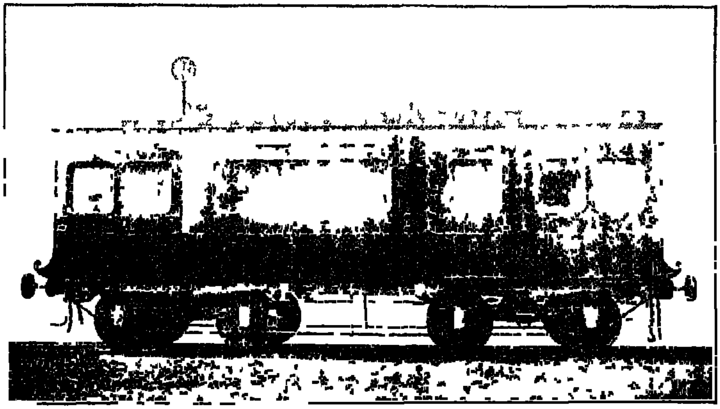
Now, the Great Western uses no roller to level its track,

and lays its rails on cross sleepers like other companies You can see them being pickled at Hayes by the side of the canal, the yard looking as though boys had been playing there with a box of gigantic bricks, each 9 ft long less an inch, 10 in wide and 5 in thick Those logs are passed through a machine that bores in them at once all the holes for the bolts and treenails, so that there can be no trouble about the accuracy of the gauge, and then they are pickled wholesale in the tar works into which the sleeper yard tails out—a much more speedy process than the treatment of the longitudinals in the days of Brunel But though his methods were in some particulars mistaken, what a fine, spacious road he made!

Starting from Paddington, the most comfortable of terminal stations, designed by Brunel and decorated by Digby Wyatt, we soon pass Kensal Green, where the nearness to the North Western tells of that short period when it was proposed to join that line a little beyond where is now Willesden Junction and run with it into Euston Soon we are on the Hanwell embankment, which, not being made on a wide enough base, burst through the stratum of clay and took more material, most miscellaneous, to repair the damage than was used in the first instance to make it, and then we are running along Morton Peto's first contract the Wharncliffe Viaduct over the Brent, with its eight elliptical arches of 70-ft span

Southall, with its water-softening tower, comes next, and then we reach West Drayton, where Daniel Gooch, then a few days older than twenty-one, the youngest of locomotive superintendents, came to live in August 1837 and proceeded to build the engine-house Into this the two first engines of the line were run after being hauled up from the canal barges, berthed about a mile away, by which they were delivered from their makers in the north The first to arrive was the Vulcan, put first into steam on the 9th of January following, the third to come,

the North Star, was delivered by barge at Maidenhead, and put into steam there on the 15th, that being the other end of the section of the line to be first finished On the 4th of June the line from Bishop's Road was opened somewhat ingloriously, for the Æolus that drew the train burst a tube at West Drayton and put her fire out, so that the following train had to come up and push the first all the way to Maidenhead, where it stopped on the Buckinghamshire side of the river, the bridge not being ready



The first Royal Saloon built in 1840 for Queen Victoria

Half-way between West Drayton and Maidenhead is Slough, where matters were rather stormy in these early days The Eton authorities, fearing that the railway would demoralise their boys, had obtained the insertion in the Act of a clause that no station should be built there, and that the company should provide policemen always on duty for some distance up and down the line to prevent the boys being run over or running up to London The railway employed the police as required, but as the clause said nothing about stopping the trains, they stopped them all and used two rooms in a neighbouring tavern for the purposes of the forbidden station An injunction was applied for, but not granted, and, the Eton boys being

none the worse for the railway the opposition died out, and in time the Windsor branch was built

Slough is quite a landmark in the history of electric telegraphy In 1839 Cooke and Wheatstone, who had been experimenting on the London & Birmingham, laid their so-called galvanic telegraph between Paddington and West Drayton, the wires being out of sight in a tube some six inches from the ground, where it worked well and unnoticed except by railway men In 1843 it was extended to Slough and as little interest taken in it, but in 1845 there was a murder at Salt Hill by one Tawell, who, it was discovered, had fled to London by railway The police arrived at the station too late and telegraphed to Paddington for him to be stopped, and he was arrested as he stepped on to the platform The incident attracted public attention, and the commercial success of electric telegraphy was assured Tawell did for the wire what the wreck of the *Republic* did for the wireless

In 1841, according to Gooch, though the date is generally given as 1842, Queen Victoria gave up travelling by road between London and Windsor and went by railway, and the first man to drive her was, of course, Daniel Gooch, who never had a single delay with the royal train For this purpose the first royal saloon was built in 1840, a really handsome carriage 21 ft long and 9 ft wide, which had wooden wheels with wooden tyres to lessen the noise When the line was converted to narrow gauge this carriage had to be withdrawn It is now at Swindon, where, roomy as it is, it looks curiously small compared with the splendid saloon of the present day

Swindon was chosen by Gooch in 1840 as the site of the locomotive headquarters, it being at the junction with the Cheltenham branch, and the machinery was started there in November 1842 Brunel was a civil engineer, not an engine-builder like his competitors He left the designs of the first engines to the makers, and a miserable lot they

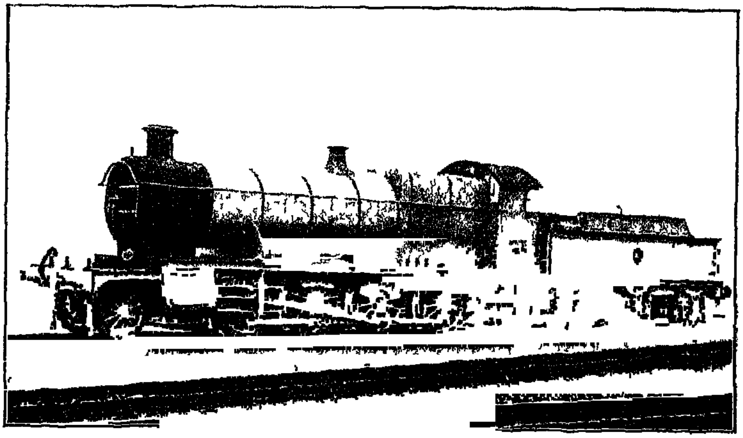
produced When Gooch went into the Stephenson works in 1836, the first job given to him was to complete the drawings for six engines for Russia of 6-ft gauge Two of these were never sent because the Russians did not pay, and they were sold to the Great Western, to be shifted on to 7-ft bases and become the Morning Star and the North Star, the latter the only trustworthy engine that Gooch had to open the line with

He had to begin to rebuild half of them as soon as they arrived, and for many weeks his nights were spent in a carriage in the engine-house repairing the engines for their work next day Being asked to report, he condemned almost all and was ordered to prepare designs for the future stock, and lithographed copies of these, with printed specifications and thin iron templates for the interchangeable parts, were sent to the contractors, so that for the first time a class of engines should be built exactly alike The first to be put into steam was the Firefly in March 1840, and with her arrival Gooch's anxiety was at an end

In 1846 he built his first passenger engine at Swindon, the Great Western, a 6-wheeler to begin with, but there being too much weight on the two leading wheels, two pairs of small wheels were substituted, and then she became the typical broad-gauge engine, the first of the thirty whose names are household words All her sisters were like her in having no flanges to their driving wheels, these being added thirty years afterwards to the survivors as they came in to be rebuilt Before they were rebuilt the thirty ran between them close on 18,500,000 miles, and they were for a time the fastest engines in the world They had 8-ft wheels, and many of them reached a speed of 78 miles an hour

In 1876 the Bristol & Exeter was amalgamated with the older broad-gauge line, and its engines were taken over, among them being James Pearson's powerful tank engines with 9-ft wheels, which ran 80 miles an hour as a daily

performance over the by no means easy road Gooch's engines worked at 120-lb pressure, Pearson's at 130 Since then engines have become much heavier and more powerful The North Star, really a 6-ft engine, had 724 sq ft of heating surface, the Great Western had 1751 and her younger sisters, which differed slightly in details, had more, though none exceeded 2000, the Great Bear has 3212 and works at 225 lb, her boiler is almost as long as the Great Western was over all, but being narrow gauge she is 2 ft less in width Her next of kin are now hauling trains of such weights as Gooch and Pearson never dreamt of, at speeds on the same stretches ranging up to 85 and more



The first of the "Consolidation" Engines built in England

As with the passengers so with the goods The first engine Swindon turned out was the Premier, a 6-coupled goods engine that would be useless in front of such loads as are drawn by the modern engines that accomplish the company's little task of dealing satisfactorily with 50,000,000 tons of merchandise and minerals in a year

The engines of the line designed by Mr Dean, and more recently by Mr Churchward, are deservedly in high repute. Ranging from the 4-cylindered Great Bear downwards,

they are the very embodiment of power and speed There are goods engines that haul their hundred trucks of coal, as in our picture, with no more fuss than their predecessors did forty, among them the first real "Consolidation"—that is an engine with a leading pony truck and 8 wheels coupled—ever seen in England It was at Swindon that the Belpaire firebox was introduced, in which the boiler sheet is parallel with the crown sheet so that the stay-bolts are at right angles to both surfaces, an improvement soon afterwards adopted by the Midland and other companies And the "Cities" and "Counties" with their taper boilers and these Belpaires are among the most famous of express passenger engines

One run in particular cannot go without notice, that on the 9th of May 1904, when the American mail was brought from Millbay Crossing to Paddington, 246 miles, in 227 minutes The train, four 8-wheeled mail-vans of 22 tons each, one 8-wheel sorting-van of 25 tons, and 35 tons of mails and specie the engines, first from Plymouth to Bristol, No 3440, City of Truro, wheels 6 ft 8 in, cylinders 12 × 26, heating surface 1816, pressure 180 pressed to 195, second, from Bristol to Paddington, No 3065, Duke of Connaught, a 7-ft single, cylinders 19 × 24, heating surface 1561, pressure 160 The average speed from start to stop 71 miles an hour, 77 miles an hour down Rattery Incline, 80 miles an hour from Taunton to Bristol, Swindon to Paddington, 76 miles 47 chains, in 58 minutes 47 seconds, over 80 at Goring water-troughs, at times over 90, sometimes over 100, "the motion resembling a sliding along the smoothest ice and not the slightest oscillation"

Richard Jefferies tells a well-known story of Brunel and Gooch, while eating their sandwiches among the furze bushes, agreeing to make the centre of their great railroad the spot where a stone should fall The stone was thrown, and where it pitched the peg was placed The story may be true in part if for "great railroad" we read "great works."

Gooch, as we have seen, chose the site in 1840, long after the line was laid out, and, before he sent in his report, Brunel went down with him to look at the ground, then green fields, and agreed with him as to its being the best place

Anyhow the haste to open the line was such that work hereabouts went on regardless of weather, the saturated clay slipped to its angle of repose, and piles were driven to restrain it, the piles began to slope as the clay moved, and chains were linked from pile to pile to keep them upright, and the trains now run over tons of cables buried in the earth When the road only went to Bristol, this 273 ft above Paddington was the summit level of the line, now the greatest height to which the Great Western climbs is at Princetown on Dartmoor, 1500 ft higher

Round Brunel's peg Swindon has grown as the system has grown It is a big place, and the pleasantest of all the railway works It makes all the carriages and wagons and all the engines, except the few built at Wolverhampton, where, as at Worcester and Newton Abbot, there are branch repairing shops It is a town in itself, occupying over 250 acres, and inhabited during the daytime by 13,000 men, 8000 of whom are in the locomotive section, the rest being in the wagon works or in the carriage works which are south of the line

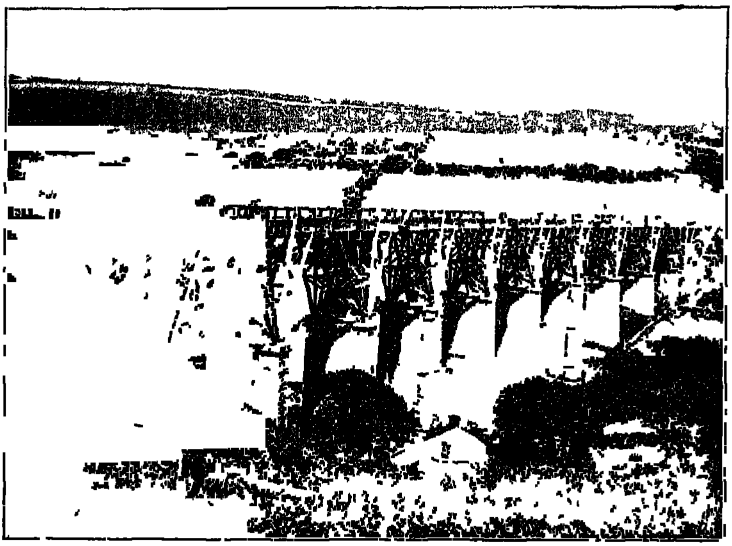
In the wagon works you see a smith's shop which is a tenth of a mile long, a machine shop, where the carriage bogies are made, which is 123 yards long and 78 yards wide, and a frame shop where you find multiple drilling-machines ranging up to fifty spindles There is a stamping shop where, besides the steam hammers and drop hammers, you see eighteen hydraulic forging presses, seven of a 100 tons and two of 200 tons, and, after a carriage-lifting shop of vast proportions and a wagon-lifting shop of 160,000 sq. ft, you may get a peep into a washing-shed where the men are working as quickly as window-cleaners, on raised platforms edged with water-troughs of the same sort as those between the lines for engines to pick up from.

In the locomotive works the chief things you remember are the old erecting shop, nearly 100 yards square, which is used for tenders and goods engines and has seven dozen engine-pits, the new erecting shop for passenger engines, which is over 100 yards wide and 160 long, and is all worked by electricity, the points and crossings shop, the rolling mill, not used for rails but sundries, all the scrap of the works being used up again, cut into pieces, stacked in bundles, committed to the furnace, worked into blooms under the steam hammer with the usual fireworks, and reheated and run through the rolls, the shop where the springs are made, leaf, spiral, and volute, the frame shop, in which bundles of a dozen frames are slotted at the same time, and the boiler shop, in which 200 new boilers can be made in a year while 900 old ones are being repaired, the most conspicuous tools being the hydraulic riveter with a 12-ft gap, a firebox drilling machine with a revolving bedplate by which almost all the holes in a firebox can be drilled at one setting, and the hydraulic flanging press of 600 tons with ten rams pressing the large fireboxes into shape in two heats and the smaller fireboxes in one

But the most wonderful thing of all is Mr Churchward's engine-tester, which to a great extent has done away with the trial runs of new engines on a line becoming every year more crowded at all hours This is a brick-lined pit fitted with ten carrying wheels that can be adjusted to any distances, and connected with much ingenious machinery that registers all that is worth knowing about a railway engine The engine is run on to a table and lowered by sixteen screw-jacks on to the wheels of the tester, and the drawbar hook is hitched on to the dynamometer so that it cannot get away, although it is hauling at it all the time as if it were a train, and the pull of the drawbar and the speed of the carrying wheels give the measure of power

The engine cannot move ahead, but it is started just as

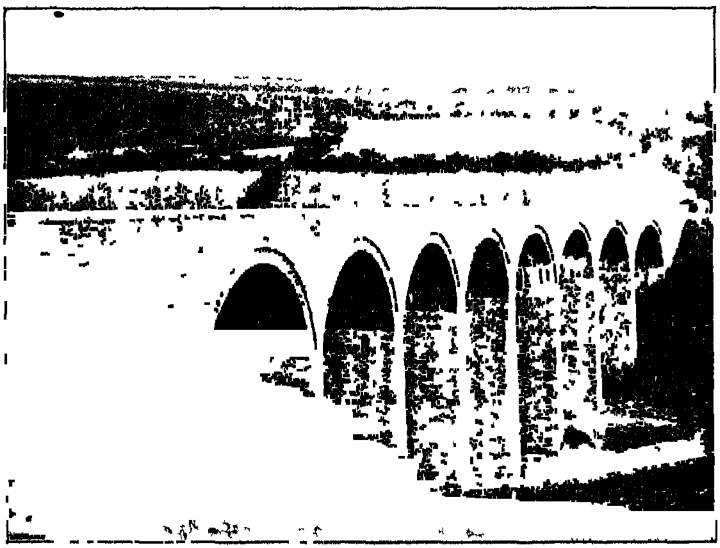
if it could, and quickly working up into speed, as if it were leaving a station, faster and faster it goes until the noise is appalling. A 4-coupled engine running at seventy miles an hour and not moving an inch is a sight not easily forgotten. Coupling rods at over 300 revolutions per minute tend to appear as streaks, and we dare not venture to ask ourselves what would happen if one broke. And what would happen if the drawbar broke which is



One of Brunel's famous Trestle Bridges in Cornwall, now being replaced by—

holding back the roaring locomotive as if it were a raging lion? "As, however," says a writer in *The Engineer*, "the drawbar pull of something over one ton is considered good duty at seventy miles an hour, representing as it does nearly 500 horse-power net, there is not much danger." When we have become a little reconciled to the deafening roar of the wheels, and made up our mind that nothing is going to fly to pieces, we can begin to learn things. In the first place, we see that the bearing-springs of the engine

have no movement; this is because the locomotive is virtually running on a perfectly smooth and rigid road; there is no rolling or pitching. We have, in fact, nothing but the internal disturbing forces to act. They assert themselves by a tendency to fore-and-aft oscillations, not at all marked at 40 miles an hour, not even at 50 or 60, but becoming violent at 70. At these enormous velocities of heavy moving parts the whole machine seems to be alive,



—these substantial stone structures. Gover Viaduct.

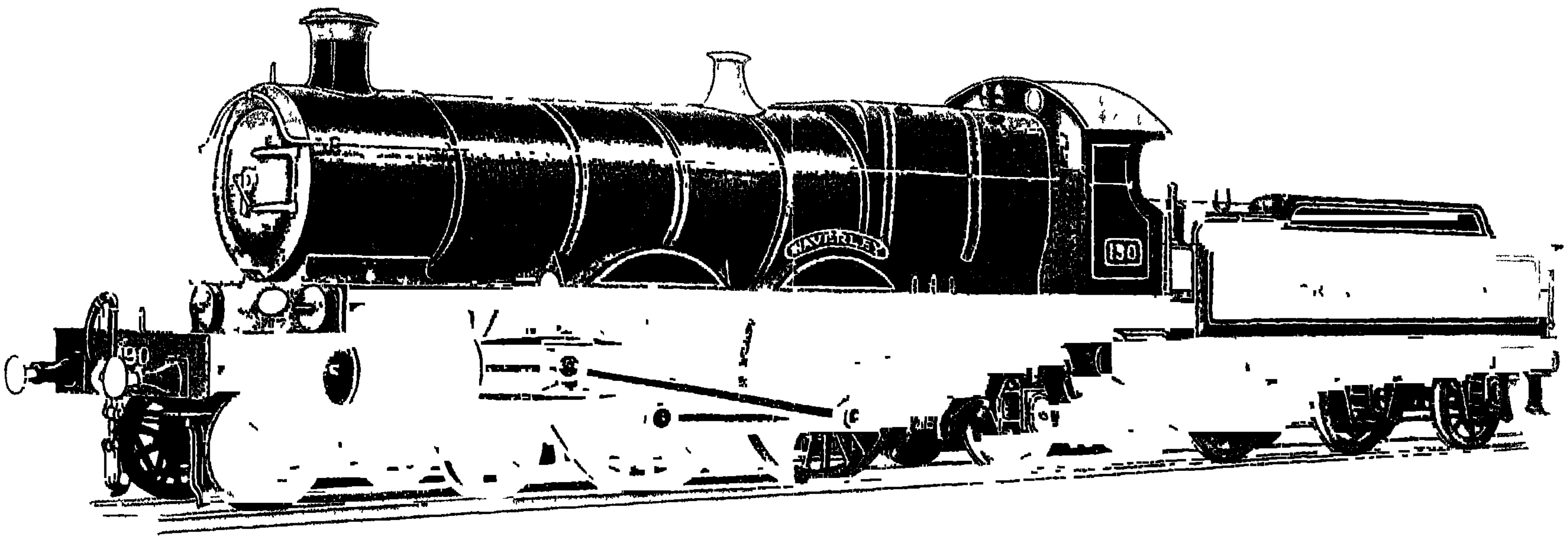
and we can very well understand that no one cares to run an engine being tested up to 80 miles an hour, while 60 is considered sufficient for all useful purposes." The engine is not run to waste, for the carrying wheels drive an air compressor that supplies the pneumatic tools. Not only are the measurements taken of speed and power; the coal burnt and the water evaporated are accurately noted, and the chimney delivers into a box that forms a receptacle for ashes and anything else ejected by the engine, all of

which is examined and reported on In short, the engine is put in the pit and made to give an account of itself

A day at Swindon would require an article, a week at Swindon would fill a book It is a place where there is always something new, for Great Western engines and carriages are always being improved upon in build if not in appearance And there are new tools and new ways One thing is clear it has produced a stud of engines, 2600 of them, so well adapted for every call that their everyday work is among the very best that is done, and a stock of carriages, 77,000 vehicles in all, that are in only a few cases equalled and in none are excelled

The way to Cornwall used to be through Swindon and Bristol, now the expresses go off at Reading—where the signal works are—and join the old road at Durston Junction near Taunton, on what was the Bristol & Exeter, which, continuing the broad gauge through Somersetshire, was opened throughout in 1844 Here Brunel had a more difficult task than on the original road, but he made the best of it, though he could not avoid a four-mile rise to Whiteball tunnel of 1 in 227, and some short stretches of 1 in 90 When, however, he came to continue the road to Plymouth as the South Devon, he frankly despaired of locomotives being of use in such an undulating country, and, considering his experience with his first engines, it was not to be wondered at So he made it to be worked like the London & Croydon and the Kingstown & Dalkey, on the atmospheric principle to which gradients were said to be of no consequence, and he went ahead almost regardless of hill or dale The system, in which the trains were attached to pistons sucked along a tube laid between the rails, had but a short life, and the towers of the engine houses at Exeter, Newton Abbot, and Totnes remain as the monuments of his last fiasco

There followed the Cornwall line, which the Great Western holds on a lease for a thousand years Here his



THE GREAT WESTERN RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 190

DESIGNED BY MR G J CHURCHWARD M INST C E

BOILER	Length	14′ 10″
	Diameter	4′ 10¾″
	,, outside	5′ 6″
CYLINDERS	Diameter	18″
	Stroke	30″
TUBES	No	250

FIRE BOX	Length	Outside	9 0″
		Inside	8 2 7/16″
	Width	Outside	5′ 3″ / 4 0″
		Inside	4′ 9″ / 3′ 2⅝″
HEATING SURFACE	Tubes	1988 65	=2142 91 sq ft
	Fire box	154 26	

DIAMETER OF WHEELS	Bogie	3 2″
	Coupled	6′ 8½″
	Trailing	4′ 1½″
GRATE AREA		27 07 sq ft
WORKING PRESSURE		225 lb per sq inch

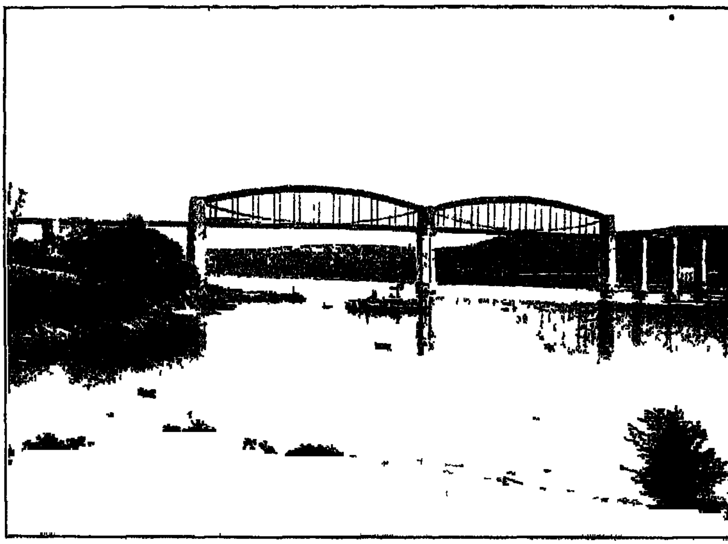
		Tons	Cwt
WEIGHT IN WORKING ORDER	Engine	70	10
	Tender	36	18
	Total	Tons 107	8
WATER CAPACITY		3000 galls	
COAL CAPACITY		6 tons	

daring and skill had full scope in designing the forty or more wooden viaducts with which he crossed the valleys as he had begun to do in South Devon Two of these were over 1000 ft long, and some over a 100 ft high Miracles of struts and braces, these timber structures have lasted their time and have been, or are being, replaced by long rows of monotonous granite arches Running through Cornwall over the trestles one cannot help thinking the stone viaduct rising alongside will prove a safer road, but when on the arches regret is inevitable at the fast disappearing trestles which were so much more interesting and picturesque

Across the Tamar Brunel took the Great Western through the air by what is known as the Saltash Bridge Of this wonderful structure of nineteen spans, all but two of which are wider than the widest arches of that over the Thames at Westminster, the pivot on which all depends is the central pier which goes down to the solid rock nearly 90 ft below high-water mark An iron cylinder, 100 ft high and 37 ft across, weighing 300 tons, was sunk through mud and gravel and clay, and it took eight months to do it, and this was filled in with granite masonry Then the top of the cylinder, some 12 ft high, was taken away, and the pier left as we see with the four octagonal iron columns rising to the road level Over each of the smaller openings the railroad is carried between two longitudinal girders, and over the main spans between similar girders hung at intervals from the main truss, which rises 56 ft in the centre and is 260 ft above the base of the foundation Each truss consists of an arched, wrought-iron oval tube and two suspension chains, one on either side of the tube, connecting its ends, and the rise of the tube above its abutments on the top of the piers being the same as the fall of the chains below, the two spans together seem to be supported by two intercrossing lines of beauty At eleven points the chains are joined to the tube by upright standards

braced by diagonal bars to resist the strains due to unequal loading, and thus each truss is a combination of an arch and a suspension bridge

The bridge carries but a single line of metals, and when seen from the road-level looks very narrow for its massive sides, but from the river the narrowness is unnoticed and the massiveness hidden by the elegant proportions as in all the bridges of Brunel It began to be built in 1854

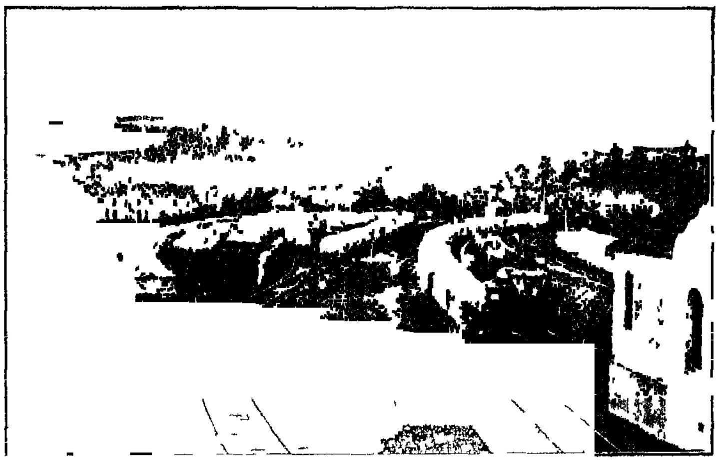


Saltash Bridge The last bridge built by Brunel

and was opened in 1859 Some time before it was finished Brunel had to go abroad owing to illness, and when he returned to die he went just once to see it complete, for it was the last of his works

the London booking offices flowers are shown fresh every day from the farthest south and the farthest west, and much else is being done to popularise the finest holiday resort in England for those who like sunshine and sea air, a glorious beach of silver sands and purple rocks, and water such as Hemy paints, whose blues and greens no one believes in but those who have been there

Down St Austell way you may notice one of the white trains containing not chalk or lime but kaolin from the

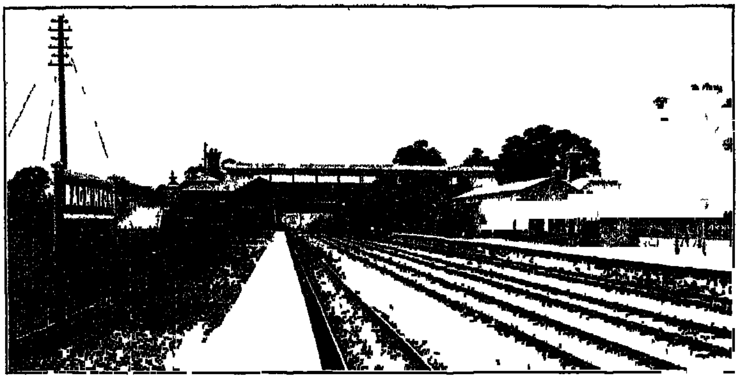


China Clay Trains at St Austell

weathering granite, and ponder over the intricacies of trade which ships this white stuff to China for the Chinese to make their porcelain with At Penzance in the spring you will see the Scilly boat come in laden with cut flowers for London and Manchester and our other chief centres of distribution

It is not only from Cornwall that flowers and vegetables come by the Great Western, for there is the vast trade at Weymouth from the Channel Islands, those fragments of Cornwall adrift on the coast of France that tell of the days of long ago before the sea broke through Weymouth is

busy all the year round, and the fleet at Portland contributes no small share to the bustle Nowadays when the men of the fleet are going on leave the railway opens a booking office on board each ship and issues tickets to everywhere The numbers run to 10,000, or maybe more, one watch leaving when the other returns At three in the morning Weymouth harbour station will receive the first returning special, and by breakfast-time 5000 men will have been taken back to their ships, at ten o'clock the second watch will land, and in three hours all that 5000 will be on their way east, west, and north.



Badminton, an up to date Typical Station

The Weymouth line used to leave the main road at Chippenham, it now goes off at Reading, just as the junction for South Wales used to be at Swindon and is now at Wootton Bassett A new line this, over thirty-three miles in length, with three tunnels through the Cotswolds, four viaducts, and about a hundred bridges, and, with no gradient steeper than 1 in 300, and no curve less than a mile in radius, it is one of the easiest of our express routes Through Badminton it goes—a typical station of the new style, the model of many others, with the double central track and the platform tracks usable as sidings—through Sodbury and Patchway to the Severn tunnel

This tunnel is the great engineering feature of the Great Western. It is under an estuary where the tide rises 50 ft., the highest tide-range anywhere in the world except in the Bay of Fundy. It was begun by the company in 1873, but the water broke in disastrously, and in December 1879 the works were handed over to Mr. T. A. Walker, the contractor, whose book on the subject is one of the most interesting stories of successful grappling with incessant difficulty.

He started with desperate endeavours to pump out the water from the company's abandoned works; the pumping power was increased and increased, but by some unhappy chance the pumps broke down one after the other just as they were telling on the persistent stream. An iron door had been built by the company in the heading under the river, some thousand feet from the bottom of the shaft which had been left open when the water broke in; and this it was decided to shut.

Lambert, the leading diver, started on his perilous journey armed only with a short iron bar, and carefully groped his way in total darkness over the things which strewed the bottom of the heading, past upturned skips, tools, and lumps of rock, which had been left in the panic of 1879, until he reached within 100 ft. of the door, when he found it impossible to drag the air-hose after him, as it rose to the top of the heading and its friction against the rock and the head-trees offered greater resistance than he could overcome.

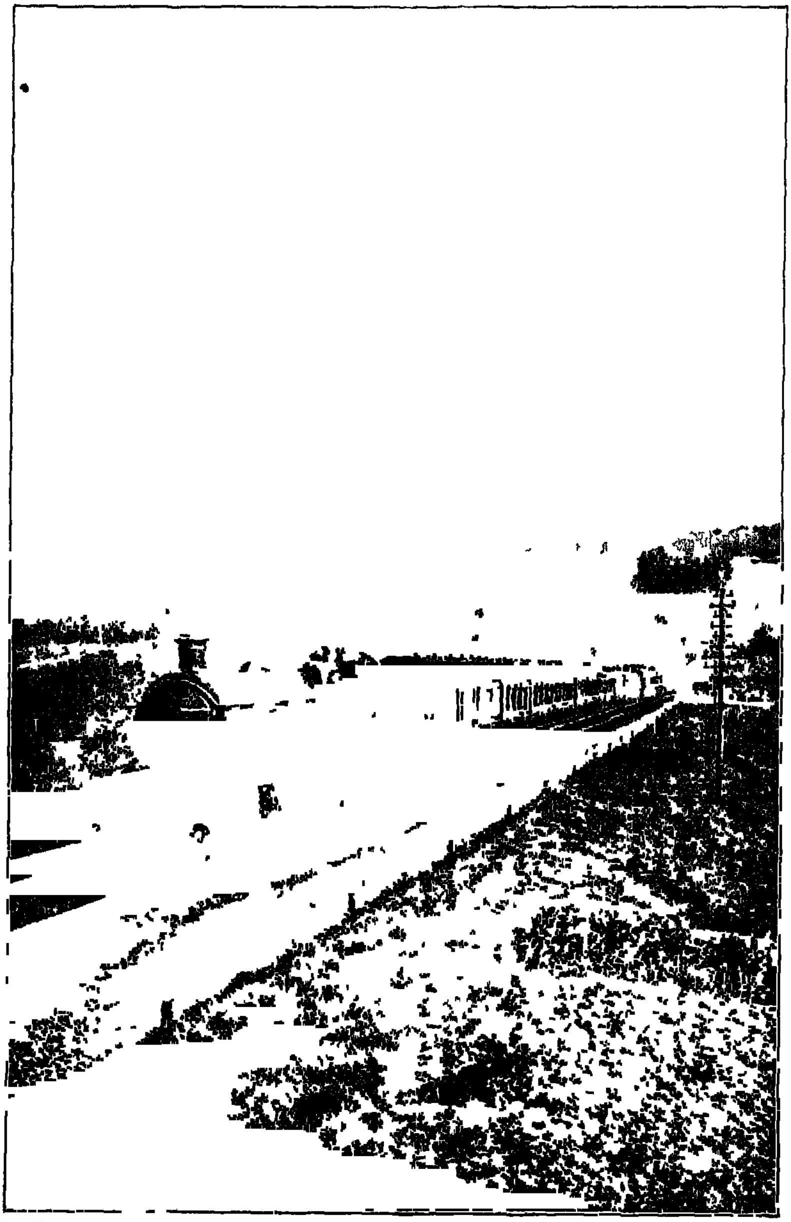
Then the Fleuss diving-dress was sent for, that knapsack of compressed oxygen which delivers into a mask worn over the face. The inventor attempted to get to the door, but failed. Then Lambert was induced to try the new invention, and after a little practice he went again along the heading, reached the door and pulled up one of the rails. Two days afterwards he went again and shut the door and screwed the valves, being away an hour and twenty minutes. Slowly the water sank when the pumping began, and when it was low enough to allow a man to wade to the door the

mystery of the slowness became clear There were two valves, one with a right-handed screw, the other with a left-handed one, and Lambert, not knowing this, had screwed both to the right, opening one and shutting the other

The inflow being checked, the work went ahead But trouble succeeded trouble most unexpectedly In 1883 the water burst in at the rate of 27,000 gallons a minute, and again Lambert had to be called on to go and shut the door, and once the tidal wave broke in and flooded both

The Gloucestershire end of the Severn Tunnel

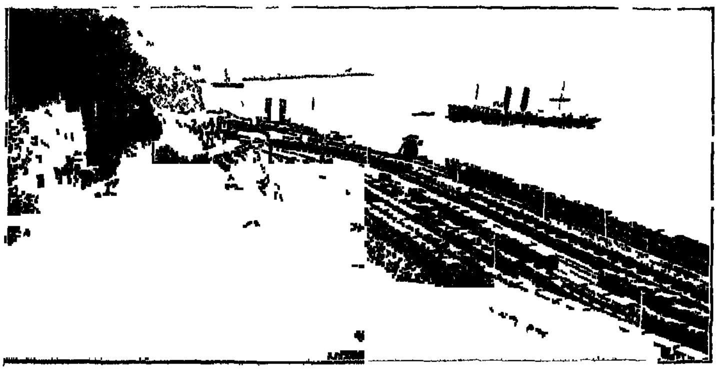
cuttings and tunnel, and once all the approaches were choked with snow But at last by pumping 23 million gallons a day, and using 76½ million bricks and 37 thousand tons of cement, the 3623 men finished in seven years a tunnel that is kept dry by six Cornish beam engines with 70-in cylinders, pumping 75 million gallons a week, installed in an engine-house that is one of the sights of the line The tunnel, the longest in the kingdom, has a length of 4 miles 624 yards, Chipping Sodbury tunnel, the next longest on the line, measures 2 miles 979 yards



I—E 60

THE "CORNISHMAN" NEAR BOX, RUNNING AT FULL SPEED

Cardiff is the main junction for the Great Western route to Ireland Here the Birmingham express, coming down by the west, transfers its passengers to the London train, and the Plymouth and Weymouth people, arriving by way of Bristol and the Severn tunnel, join in Passing Neath, with the ruined castle on one side and the ruined abbey on the other, we are soon at Swansea, where the old Oystermouth, still a steam tram-road, leads out on to the Gower peninsula Then we reach Whitland for Tenby, the happy hunting ground of the shore zoologist, then Clarbeston Road for Milford Haven, where every endeavour to make a great port has ended in failure, and then by way of Goodwick we reach Fishguard Harbour

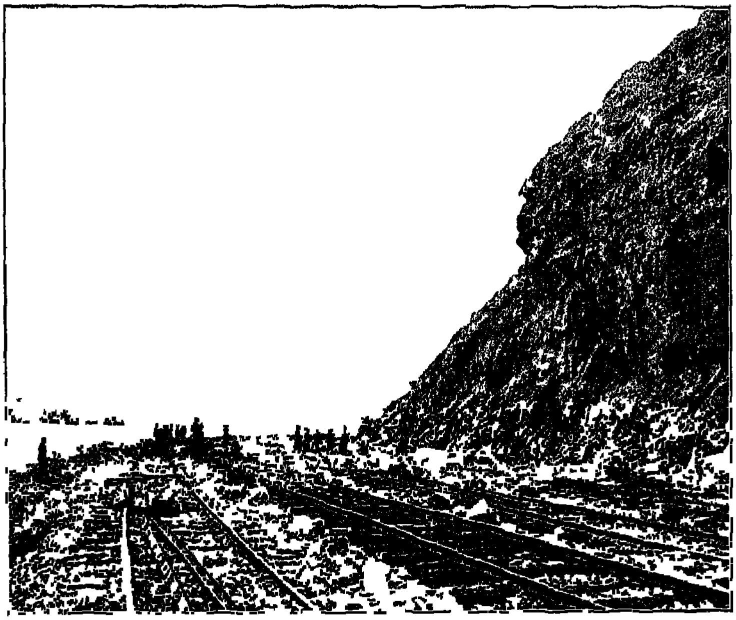


Fishguard Harbour

Fishguard seems to have been discovered by the French, who marched there from Carreg-gwastad Point, a few miles to the south, in 1797, when they began their invasion of Wales But Lord Cawdor with the militia and volunteers, the territorials of the time, aided by the women, the red in whose apparel caused them to be mistaken for a reserve, so welcomed the invaders that they surrendered at discretion The little port at the mouth of the Gwaine has only come to its own It was the terminus originally intended for the South Wales line in 1844, which

was to run there from Standish, 162 miles, "the 250 miles between London and Fishguard to be covered in five hours"—an expectation that was to be realised more than sixty years afterwards

It is a wild spot, that may develop into a pleasant seaside town, worthy of description by a second Giraldus Cambrensis, around the nucleus of the fishermen's white



Making the line to Fishguard Before blasting—

cottages and the railwaymen's village of a hundred and twelve houses built by the railway company in thirteen different styles, that give it the appearance of a garden city founded on a rock And the rock is hard enough, as can be seen from our illustrations, in one of which we have the line as it reached the corner, while in the other we have it after the corner was blasted away a few minutes later and the road to the harbour laid open.

The company having hard rock, deep water, and a free hand, made the best of their dominion, and the result is a really sensibly designed railway port, in which everything has been thoroughly thought out and provided for Take, for instance, the arrangements for the cattle trade Instead of bringing the beasts ashore on to the road, as is usually done, with all the confusion and unpleasantnesses

—and after

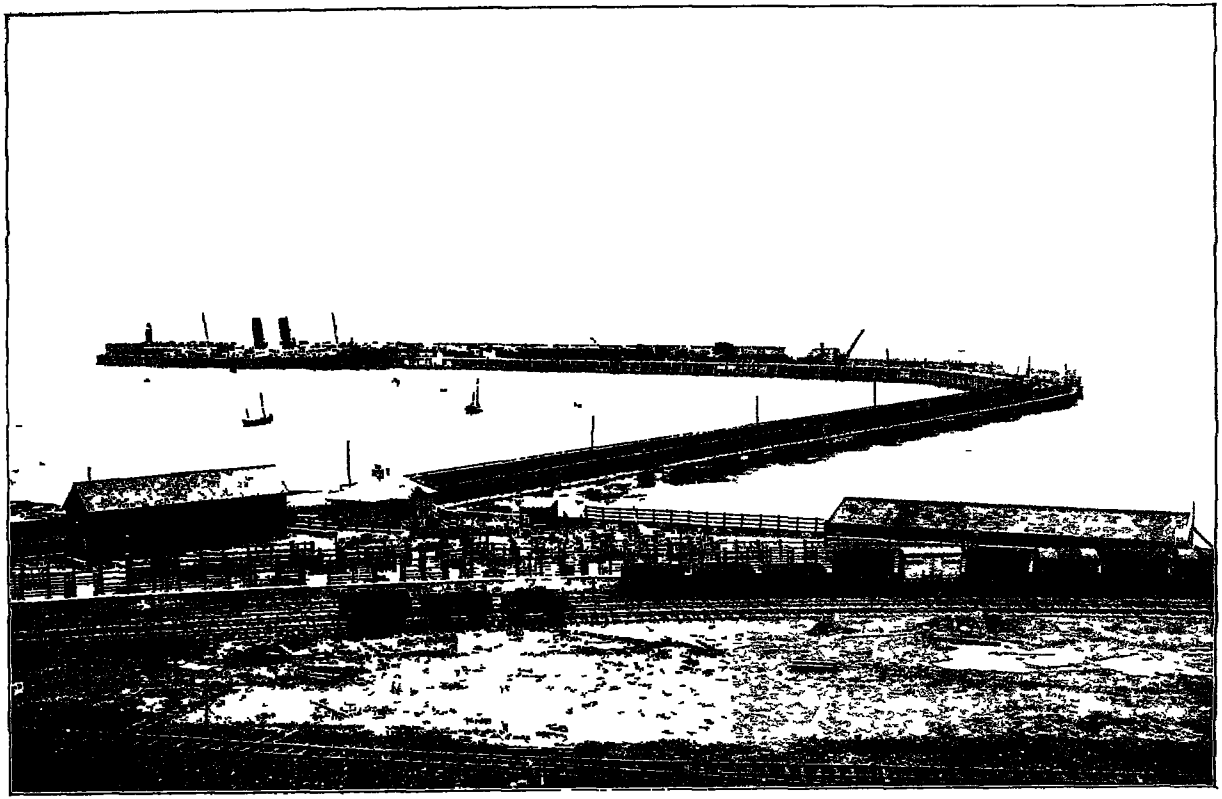
incidental thereto, a special gallery has been contrived for them below the road level, along which they can be driven without obstruction, and so arranged that it can be cleaned into the sea with a minimum of labour

Fishguard is 2902 miles from New York, nearer by 55 miles than Plymouth and 115 miles nearer than Liverpool, and this has been borne in mind by making it suitable not only for a Channel trade but for an ocean one


The Cattle Gallery at Fishguard

Soon after it was ready some of the South American liners began to use it as a port of call on the homeward journey, and so well adapted did the arrangements prove for quick despatch that the great Cunarders followed, and now it is known to all as being four and a half hours from London on the quickest American route

There are no better boats crossing the home seas than the four turbine Saints—*Andrew*, *George*, *David*, and *Patrick*—that the company have built to carry their goods and passengers to Rosslare Their trial speed was 23 knots, and they keep it up They look like small ocean liners, and not like ferry machines, and they are convenient and comfortable, handsome within and without, and well spoken of by all who have travelled in them Steady, speedy, powerful boats were wanted, for the sou'-wester swings the Atlantic seas in with such vigour that the voyage in the winter is no child's play; and after all a line depends for its prosperity on the regular passenger more than on the occasional excursionist



ROSSLARE HARBOUR

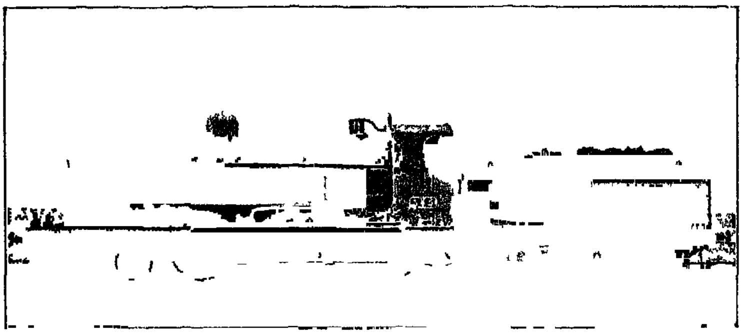
A Guard of the
Great Southern & Western

Rosslare, on the Wexford coast, answers to Fishguard The two harbours were built at the same time as the terminals of the short sea route, but boats for Waterford and boats for Cork also start from Fishguard for those who prefer a longer sea passage

All three ports are served by the same railway, the Great Southern & Western, Ireland's chief system This extends from Dublin to Queenstown, from Rosslare to Kenmare on the south coast, and, on the west coast, from Valentia to Collooney near Sligo Bay, which is fairly to the north-west of Dublin, though the line goes round by the south-west to get at it

Inchicore, near Dublin, is the Great Southern & Western's locomotive headquarters, and it has branch works at Limerick, for when it absorbed the Waterford & Limerick, and a reduction of expenses was provided for by removing the locomotive shops from there, the Limerick people got a clause into the Act retaining their

works where they were, and thereby increased the working expenses instead of diminishing them It owns about 300 engines, and among them are some excellent examples, powerful, serviceable, and smart, that would do credit to any company anywhere Of its 8000 vehicles about a thousand are passenger coaches, many of them, such as are used in the Killarney express, being as good as those of the great lines in England, and none of them so bad as some of our survivals Its carriages, like its engines and the miles of its track, number more than a third of the Irish total



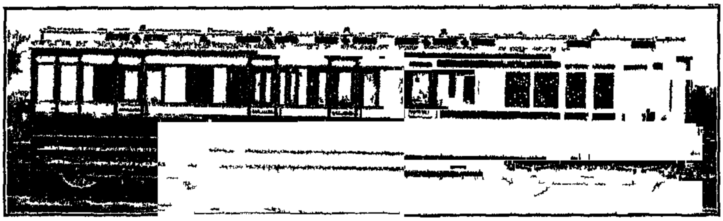
A typical Goods Engine

There are in Ireland about 3100 miles of railway, and of these the Great Southern & Western owns over 1100, the Great Northern and the Midland Great Western coming next with 1080 between them in almost equal shares. The English companies are beginning to take more interest in Irish matters in a practical way, not only have the Great Western gone to Rosslare, but the London & North Western have been the owners of the Dundalk & Greenore since 1873, and the Midland have an Irish section farther north

The oldest railway in Ireland is the Dublin & Kingstown, authorised in 1831, now forming part of the Dublin & South Eastern, which also includes the once atmospheric

Kingstown & Dalkey that led Brunel astray with regard to the South Devon The Great Southern & Western was authorised as a line from Dublin to Cashel in 1844, and has grown by many amalgamations, for all Irish railways began in a small way and have had to struggle for their existence They have to depend on passengers more than on merchandise, and the whole of them together do not carry so many passengers as the London, Tilbury & Southend, nor so many goods and minerals as the South Eastern & Chatham

The gauge battle was just the sort of thing in which Irishmen would revel, and they chose their gauges to please themselves The Ulster, for instance, completed twenty-

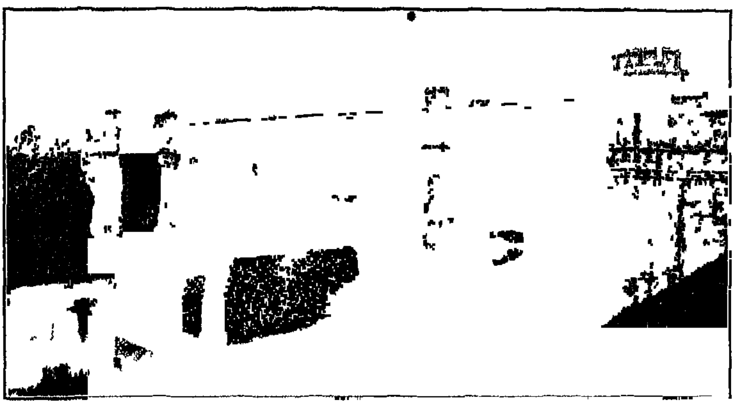


A Brake Composite

five miles of the road from Belfast to Dublin on a gauge of 6 ft. 2 in , while the Drogheda, which set out from Dublin to meet the Ulster, adopted 5 ft 2 in When this was complained of by the Ulster company, the Irish Board of Works replied that though it looked a bit awkward, yet, as there was little chance of the intervening part being finished, it really did not matter This airy sort of thing, however, was not quite good enough for the Ulstermen, who appealed to higher powers, with the result that Sir Charles Pasley, the Inspector-General of Railways, was requested to look into the matter of these Irish gauges That ingenious engineer, after trying persuasion in vain, solved the difficulty arithmetically by adding up the width of gauge adopted by every Irish company, dividing the total by the

number of companies, and thereby obtaining an average of 5 ft 3 in, which thus became the Irish national gauge Being national, it was, of course, not generally adopted, and so we have at present eleven lines of 5 ft 3 in, and five—the Ballycastle, the Cork, Blackrock & Passage, the Londonderry & Lough Swilly, the Londonderry & Strabane, and the Ballymena & Larne—each of 3 ft, and the Listowel & Ballybunion with its mono rail without any gauge at all.

The Great Southern & Western ranges over the whole



Viaduct over the River Suir, between Limerick and Waterford

of the south country It will take you to Waterford the historic and thriving, to Cork, the southern capital, to Kilkenny the ancient with its noble castle, to Killarney the beautiful in all weathers, to Valentia where the Atlantic cables go from, to Fenit on Tralee Bay, and to Limerick on the Shannon shore, the principal seaport of the west Through Clare and Galway, Mayo and Sligo it goes, and it will run you up to Maryborough and Portarlington—and thence west to Athlone and Banagher and east to Dublin where it began

Altogether it has some two dozen terminal stations, of which ten are on the coast, and wherever it

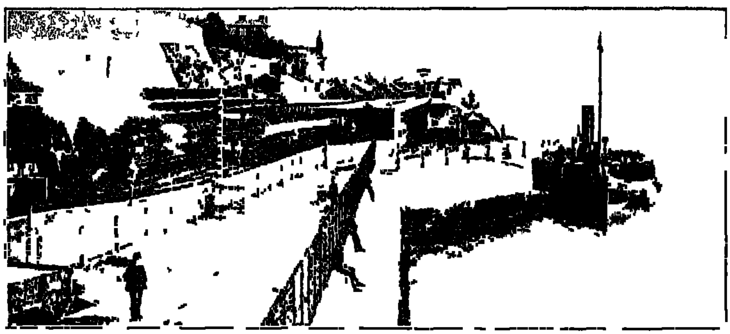
goes the scenery is delightful, though it may not be desirable to contemplate it so hurriedly as is done by those who avail themselves of that wonderful excursion, run in connection with the Great Western, from Paddington to Killarney and back for a sovereign Not only are there the lakes and hills around Muckross, there are Glengariff, the estuary of the Blackwater and that of the Shannon, Bantry Bay, the cliffs of Kerry and Clare, and the wilds of Connemara, all of which have their

Near Cahirciveen (Photo by W Lawrence, Dublin)

special admirers Really there is no scenery, coast, river, lake, or mountain, finer than there is in Ireland

Waterford, Cork, and Limerick are the commercial centres from which the Great Southern derives its revenue, all of them busy with farm and dairy produce and little else, for there is no ordinary merchandise worth mentioning This absence of manufactures and of the necessity of men living away from their work is shown by the fewness of the season tickets, where there are no offices there are no seasons There are more than six times as many seasons held in England as in Scotland, and more than

nine times as many in Scotland as in Ireland The Great Southern has but a few over a thousand ticket-holders, and comes fifth on the list, there being only 10,000 seasons in the whole country Of these 8000 are in the north, the largest season line being the Belfast & County Down with about 2500, including workmen's weekly tickets The railway returns record that one line boasts of only eight seasons, all third class, while another has three, two of which are thirds and the other first To evade payment of fare by saying "Season" on a line like this is evidently impossible, though the story goes that it was once tried by a tourist in a first-class carriage, to the amazement of the one ticket-holder who was riding with him, and the delight of the collector who instantly pounced on his man



The Mail Tender at Queenstown.

THE MIDLAND

CREST &
COAT-OF-ARMS

St Pancras Station

THE MIDLAND

THOSE who would nationalise our railways may be interested to know that the National Debt is just four times the amount of the capital of the Midland Railway Company, which is but a seventh of the total capital of the 296 railway companies in these islands

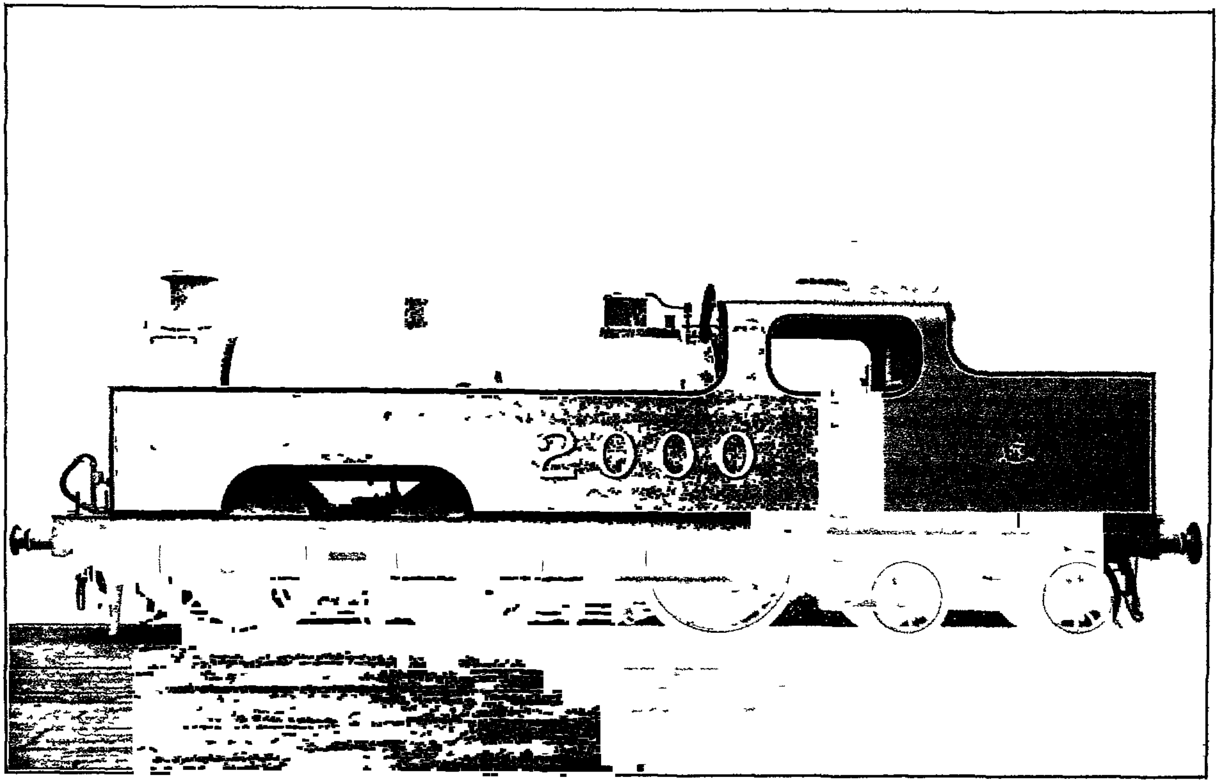
The Midland has more money in it than any other corporation, and no company has done so much to make our railway system what it is For sixty years and more it has been a thoroughly business line, thriving on the broad policy of catering for the multitude To say nothing of the improvements due to it in goods and parcels work, its passenger department gave us excursion trains and through trains and through carriages and cross-country expresses, it was the introducer of third-class carriages by all trains, it led the way in abandoning

bare boards as third-class seats and making the carriages as comfortable as the old first-class, it abolished second class, it brought in Pullman cars, bogie cars, and restaurant cars of all kinds, and revolutionised the whole routine of railway travel

Not only did it do these things for London, but for the large centres of population all over the kingdom, of which it has more on its many routes than any other company From its headquarters at Derby its trains go to Cromer, Yarmouth, Lowestoft, London, Bournemouth, Bristol, Swansea, Liverpool, Southport, Heysham, Morecambe, and Carlisle, its inland net, carefully knotted with few loose ends, covers every town of importance between Lincoln and Manchester, Bradford and Leicester, Birmingham and Leeds, across the border, in conjunction with the Glasgow & South Western, it goes to Stranraer and to Glasgow, and by the North British to Edinburgh and across the Forth Bridge, and so on to the north Including its Irish property it has close on 1800 miles of line, over which its trains travel a million miles a week throughout the year, and it owns 2900 engines and 126,000 vehicles

The origin of the Midland Railway is shown by the wyvern it bears as its crest, just as its coat of arms records the six chief cities it served in its early days, Birmingham, Derby, Bristol (with the ship), Leicester, Lincoln, Leeds (with the fleece) The wyvern was the standard of Mercia Leicester was the chief Mercian town, and the Midland owes its origin to the Leicester & Swannington, from whom it took over the crest when it took over the line

For years the Leicestershire coal-owners had been sending their coal into Leicester by carts, while the Nottinghamshire and Derbyshire owners were sending in theirs by canal, when in October 1828 William Stenson of Whitwick happened to see the Stockton & Darlington line He made up his mind that somehow or other he would have a railway that would take the place of his carts, and, being a



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A HEAVY 10-WHEELED TANK ENGINE

capable and energetic man, he went out surveying and found what he considered a suitable route. Who could help him in his project? The reply of his two partners was "John Ellis of Beaumont Leys, near Leicester." And to him he wrote. He made no mistake, for John Ellis, as his portrait in the Board Room at Derby shows him to be, was a real king of men.

Ellis appreciated the importance of the proposal, and after going over the proposed route with Stenson, went off to Liverpool to consult his friend George Stephenson, who was then busy with the Liverpool & Manchester. He found him in Rainhill cutting, so very much out of humour at something that had gone wrong that he judiciously asked him to dine with him off a beef-steak at the village inn close by a few hours later. There, after dinner, Ellis produced his map and began to talk until "Old George," agreeing that there was "something in the scheme," asked him when he was going back to Leicester. "To-night," said Ellis. "Then I will go with you," said George; and with them went his son Robert. The Stephensons, with Ellis and Stenson, went over the route, and the result was a meeting at the Bell Hotel in Leicester, where the Leicester & Swannington Company was formed, with a capital of £90,000 in £50 shares. "Now, gentlemen," said Ellis, taking a large sheet of paper, "how many shares?" "Put me down for fifty," said George Stephenson. Nearly £60,000 was subscribed, and Thomas Paget, the local banker, agreed to lend £20,000 more.

George Stephenson was asked to become engineer. "No," was the reply; "I have thirty-one miles of railway to make, and the Liverpool directors think that is enough for any man at a time." "That being so," said Ellis, "is there any person thou canst recommend?" "Well, I think my son Robert is competent to undertake the thing." "But wilt thou be answerable for him?" "Oh yes, certainly." And thus it came about that George

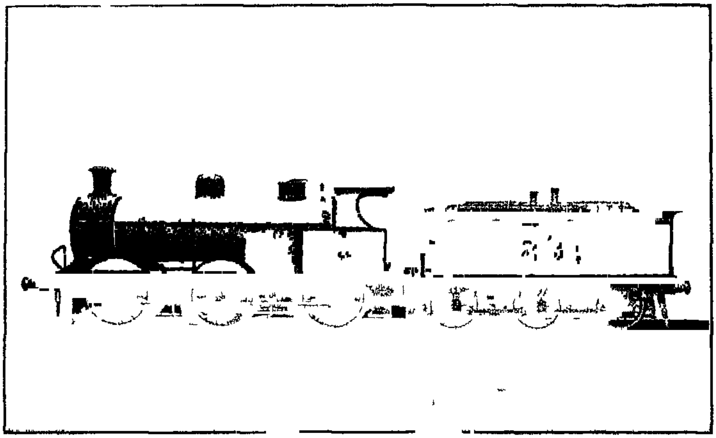
Stephenson was the first shareholder, and Robert Stephenson, aged twenty-seven, got his first job as chief engineer

Robert Stephenson altered Stenson's route a little to improve the gradients, and on the 30th of May 1830 the Act was obtained, being one of the earliest railways to be authorised on the first application As there was no ordnance bench-mark then in the district, the slate slab forming the doorstep of the offices at West Bridge was used as the base line About a mile and a half out of Leicester was the Glenfield tunnel, a little over a mile long, made at considerable difficulty and much expense owing to its being through running sand which required a wooden tunnel to be made to keep it in check while the brickwork was put in Through it the rails were laid on longitudinal timbers held to gauge by cross-ties, on the embankments the rails were on cross sleepers of oak, in the cuttings they were on stone blocks laid diagonally The Bagworth incline, which could not be avoided, was worked by an endless rope running on a horizontal wheel, by which the empty wagons were hauled up by the loaded ones running down

The first engine to arrive was the Comet, weight 9½ tons, made by the Stephensons at Newcastle, shipped from there to Hull and sent thence by canal, and put in steam on the 5th of May 1832 "Edward," said John Ellis to his son Edward Shipley Ellis, destined to be another great chairman of the Midland, "thou shalt go down with me and see the new engine get up its steam" And the first trial trip was made of the first engine to run in the Midlands

The opening was on the 17th of July. On that morning the platelayers had lifted the rails rather too high at one place in the tunnel, and when the engine reached the spot the chimney caught the top of the arch and was knocked down, with dire results to the faces and clothes of the people in the train of open trucks. This incident is worth

remembering, as it is the origin of the legend that Trevithick's engine lost its chimney on the first trip from Penydaren



A Midland Goods Engine

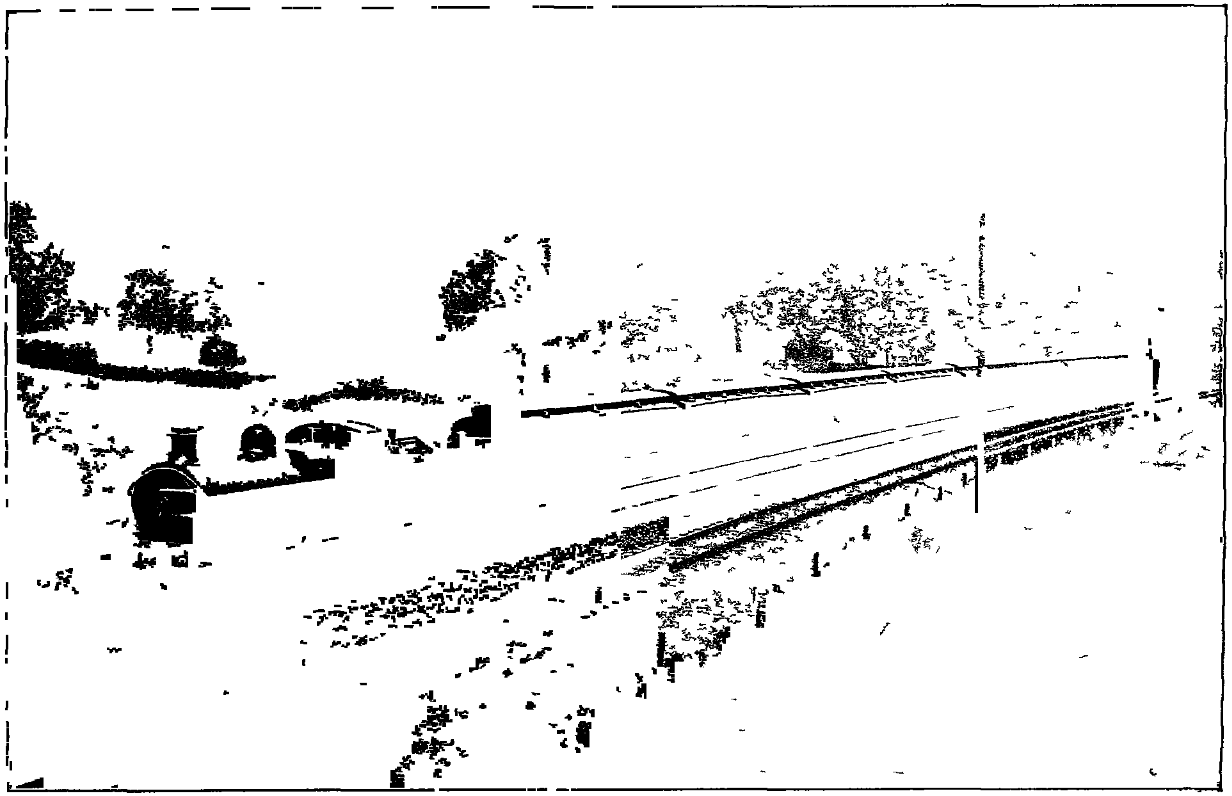
Among the visitors were William Jessop, the inventor of the edge rail and the railway chair, and James Oakes, representatives of the Erewash Valley coal-owners, who saw that their trade by canal to Leicester was practically at an end They returned and reported that something must be done at once, and on the 16th of August they and a few others in the trade, at one of their usual weekly meetings at the Sun Inn at Eastwood, were seated round the parlour table discussing the gloomy outlook, when it was decided that there was no other plan for their adoption than to attempt to lay a railway from their collieries to the town of Leicester, and a committee was chosen to take the necessary steps The outcome was the Midland Counties Railway project, which began with the Erewash Valley and ended by leaving it out

The idea was to make a line, from the old Mansfield & Pinxton tram-road, to Leicester, but the money required

could not be raised locally, and application was made to certain wealthy men in Manchester, Leeds, Liverpool, and elsewhere, known as "the Liverpool party," of whom there was much talk in railway circles. These men provided the needful capital, but insisted on having their own way. And what they did eventually was to develop Jessop's Erewash idea into a main line from Derby to Rugby, with a branch to Nottingham. Jessop was solaced by being made engineer to the company, but he soon had notice to quit and George Rennie was appointed to succeed him, and Rennie in turn had to give place to Charles Vignoles. The proceedings throughout were surprising and most curious, and the Erewash people were furious. "They held a meeting, passed resolutions, and expressed their views in very strong terms, but they could do nothing beyond close the meeting and retire to an excellent dinner at the Sun Inn."

It was on this line that the first excursion train was run, the credit of the new idea being due to the Nottingham Mechanics Institute, who, to enable their members to visit an exhibition then being held at Leicester, made out a list of those wishing to go, interviewed the company, and secured a special train at half fares. The train was run on the 20th of July 1840; and a week afterwards the Leicester Mechanics Institute arranged a second excursion for their members to visit a similar show at Nottingham.

The success of these trains led the company to run an excursion of their own on the 10th of August from Leicester and intermediate stations to Nottingham; and that day fortnight they ran an excursion to Leicester, the announcement being so well received that no less than 2400 people took tickets, who were all carried in one train which consisted of sixty-five carriages. The matter excited so much interest that crowds gathered to see the excursion arrive. It left Nottingham at 8.30. "At 11.30," said *The Leicester Chronicle*, in a burst of eloquence, "alarm was felt at the



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THE LONDON AND MANCHESTER EXPRESS PASSING THROUGH THE CHEVIN VALLEY

non-appearance of the train An engine with several of the railway labourers started off to meet it Another feverish half-hour crept on, when a second engine carrying a few of the directors was despatched At half-past twelve, however, a thin vapour, a little smoke, then a huge undulating mass was discovered at the extremity of the horizon, and gave assurance that all was safe In a minute a long, lingering, undulating mass of wood and iron slowly emerged from the dark mass of vapour which partially accompanied it like a bodyguard, and rushed along the line with a noise resembling the dashing of a thousand surges on a rocky shore "

Next year, on the 1st of July 1841, the first excursion was run on the North Midland and Sheffield & Rotherham, and on the 5th of that July Thomas Cook, then Secretary to the Market Harborough branch of the South Midland Temperance Association, ran his first excursion, hiring the train at his own risk, selling the tickets himself, and travelling with the excursionists to look after their comfort That temperance excursion at a shilling a head from Leicester to Loughborough and back was the beginning of the business of Thomas Cook & Sons

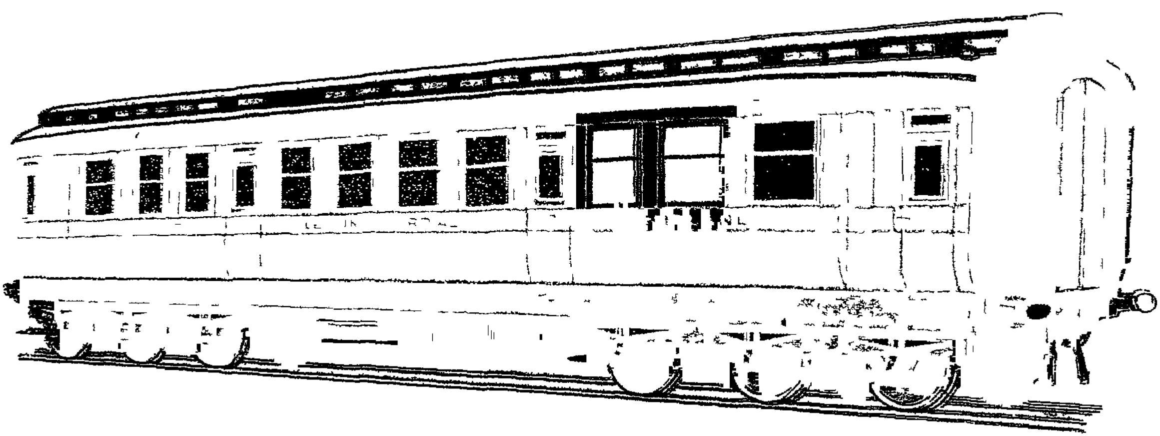
The North Midland was projected by George Stephenson to connect with the Midland Counties at Derby and run through Masborough and Normanton to Leeds It was a low-level line along the valleys, Sheffield being avoided owing to the gradients, but at his suggestion the Sheffield & Rotherham was laid out connecting with the North Midland at Masborough As made, it was 72 miles long, and had two hundred bridges and seven tunnels, and it cost £3,000,000

At Ambergate the upper half of the hill rested on an inclined bed of slippery wet shale, and, as a tunnel of the ordinary shape would not have been strong enough to resist the pressure, Stephenson made it elliptical in section, so that the flat of the arch of the ellipse should bear the

weight The work, however, had not long been finished when it was found that the solid stonework of millstone grit was being so splintered as to endanger its safety, and he removed some of the overlying mass, drained the shale, and put in a lining of iron ribs, so that it became a double tunnel of limestone and iron About a mile farther on, at Bull Bridge, the route was crossed by the Cromford Canal and the river Anker To deal with the canal he designed an iron trough the shape and size of its bed, floated it into position, and sank it on to its resting-place without interfering with the traffic, and thus the river runs below, crossed by the railway bridge, which in turn is crossed by the aqueduct At Clay Cross is another tunnel in the making of which so much good coal was discovered that with the financial aid of "the Liverpool party" Stephenson formed the company that works the Clay Cross Collieries, and as he started coke works here, and limekilns at Ambergate for the limestone brought from Crich, he soon had so many important interests on the line that he removed from Alton Grange to Tapton House near Chesterfield, where he lived for the rest of his days

According to David Stevenson, it was from Clay Cross in July 1845 that the trucks of coal were brought by the Midland to Rugby for the London & Birmingham to take on to London "What! Coal by railway?" said Captain Bruyères, a military martinet, then Superintendent of that line, "they will be asking us to carry dung next!" The coal, however, came on in trucks covered with tarpaulins to Kilburn, whence it was carted by the consignee, and this was the first coal that came to London by railway instead of by sea or canal

The same autumn that George Stephenson surveyed the route for the North Midland he made the survey for the Birmingham & Derby, which had its terminus at Derby, side by side with the other two, its avowed object was to provide a road to Birmingham and the west country,



THE MIDLAND RAILWAY

SLEEPING CARRIAGE No 2765

Length over body	65′	Extreme width	9′	Double berths	1	Electric lighting
,, ,, buffers	68′ 2″	Weight	37 tons	Single ,,	9	Steam heated
Extreme height from rail	12′ 8″			Smoking compt	1	
,, ,, at side	10′ 6″					

Separate lavatory accommodation for each passenger

but the Midland Counties were not long in discovering that it was a competing line to the south, and thereupon there began a war of rates that was leading the three companies well on the road to bankruptcy when the news of the Great Western's intention to lay the broad gauge to Birmingham brought them to their senses

One of the directors of the North Midland happened to be the celebrated George Hudson, and at his initiative proposals for amalgamation were made He is usually called the Railway King, but a far better title would be The Amalgamator, for he it was who by this move began railway amalgamations, and it was by amalgamations that most of his work was done Supported by John Ellis, who was a director of the Midland Counties, and George Stephenson, he succeeded in getting the three companies to agree, and on the 10th of May 1844 the Act was passed which formed them into the Midland Railway Company, of which he was the first chairman

It thus became the largest railway and had the longest line, 65 miles of it on stone blocks, 115 miles on cross sleepers, and a mile and a half on bridge rails Great was the saving in administration The three works, for instance, side by side at Derby, were merged into one, and in charge was placed the locomotive superintendent of the Birmingham & Derby, Matthew Kirtley, then aged thirty-one, who had begun railway life when a boy of sixteen as a fireman on the Warrington & Newton He it was who drove the first engine of the London & Birmingham to London When he took over the united works he had 95 engines, all 4-wheelers He at once introduced 6-wheelers, and in 1851 he built his first engine at Derby, it was No 158 When third class by all trains was introduced in April 1872 it doubled the length and weight of trains, this was foreseen, and on the day of the change he had 68 new engines ready, specially and successfully designed for the work He died in 1873, and was succeeded by Samuel Waite Johnson,

who held office for over thirty years In 1844 the combined works covered 8½ acres, they now, including the carriage works, occupy 206, and employ 14,000 men

So soon as the Midland Counties Company lost its identity in the Midland, Jessop and Oakes reappeared on the scene with their Erewash Valley project This time they had nothing to feel aggrieved at, for Hudson, seeing that by joining up Clay Cross with Pye Bridge he could obtain a short route to Rugby, took over the scheme for a guaranteed dividend of 6 per cent on the proposed capital, and the line was opened in 1847.

The Leicester & Swannington, which had been the origin of the group of railways, was now taken over It had been going along quietly and prosperously, but company promoters would not leave it alone, and the offers to purchase it as a branch or continuation of some opposition line to the Midland were becoming so frequent that to stop any chance of competition it was purchased on friendly terms in August 1845 For one thing it is noteworthy. One of its engines, the Samson, ran over a cart loaded with butter and eggs that had got on to the line at a level crossing To avoid troubles of this sort, the manager, Ashlin Bagster, afterwards the first manager of the London & Birmingham, suggested to George Stephenson that perhaps a whistle could be fitted to the engines that steam could blow "A very good thought," said Stephenson And the first "steam trumpet" was made by a Leicester musical instrument maker and fitted to the Samson, with such success that all the other engines had one, and every company in time adopted the idea. As soon as the line came into the possession of the Midland it was taken in hand, joined up with the main line, and extended to Burton-on-Trent

In 1846, to stop a projected railway to Burton-on-Trent from Atherstone by way of Ashby-de-la-Zouch, the Midland bought up the old Ashby Canal and its tramways.

Part of these it used, but one part, the Ticknall branch, it was content to leave, and it is still left with its toll-house and weighing-machine by the side of the canal

Hudson soon went ahead and extended the Midland from Nottingham to Lincoln, an easy matter, and from Syston to Peterborough, a by no means easy matter, owing mainly to Lord Harborough defending Stapleford Park

A First class Dining Saloon.

against the surveyors as if it were an entrenched camp held in the interest of the Oakham Canal, in which he was a shareholder The next step was the purchase of the Sheffield & Rotherham, opened in 1838, a line worth remembrance as being the first to abolish second class, "the company finding the carriages unnecessary," and getting along very well with their coach-like firsts, which were painted yellow, and their thirds, mere trucks with deal forms to sit upon, which were painted green

The Birmingham & Gloucester Act was passed in 1836

It was an inevitable line Brunel had surveyed for it too much to the east, and thus left out the towns on the way; Moorsom surveyed for it too much to the west, and left them out on the other side, and as the towns would produce no shareholders unless they were pleased, Moorsom had to modify his route until it proved acceptable The plan had one advantage—it evoked little opposition, and the Act was obtained at the first application At one end was the Birmingham Station of the London & Birmingham, at the other was the Gloucester & Cheltenham tram-line, thirty years old, which had first been worked by horses and was then being worked by steam-engines built by Tregellas Price of Neath—a little railway all by itself that those in the north knew nothing of

And between them was Bromsgrove Lickey, where the gradient (1 in 37) is so steep that the trains have to go up the two miles with an engine at both ends An inch in a yard does not seem much of a rise on a dining-table, and it is not quite so great, but it means in actual working, as at Bromsgrove, an extra cost of £5000 a year As none of the existing English engines could work up such an incline, Moorsom imported eight engines from Philadelphia, which worked fairly well, and eight more were ordered, but in 1845 J E M'Connell, in the company's own works at Bromsgrove, built a 6-coupled tank-engine that far surpassed them, and the importations ceased They were bogie engines, and it is sometimes claimed that by them was the bogie introduced into this country, but we had used the bogie long before, Puffing Billy had one, so had Wylam Dilly, so had the Earl of Airlie, and other engines on the Dundee & Newtyle built by Carmichael at Dundee in 1833 and 1834, though the bogies were trailing, while in the Norris engines they were leading

On the 17th of August the line was opened throughout from Curzon Street Station to Gloucester and developments began The London & Birmingham had given the company

access to their station, or any future station they might have in Birmingham, because the battle of the gauges was in progress and the new line stopped the advance of the broad gauge up from Bristol in the west Before its construction the only railway route from Bristol to the north was eastwards to the London suburbs by broad gauge

A First class Sleeping Saloon.

and then to the London & Birmingham by a short run on the Bristol, Birmingham & Thames Junction, afterwards known as the West London Here there was a break of gauge, with the usual troubles, but at Gloucester on the direct line the evils were more apparent; and the Gauge Commissioners went there in 1845 to see whether the confusion was as great as the evidence declared They were convinced that it was even worse—and no wonder Mr J D Payne of the Gloucester goods department took care of that. Fearing lest the extent of transfer work might be too small to impress the Commissioners, he unloaded two trains that had already been dealt with as an addition

to the usual work, and "when," says Mr G P Neele, "the members came to the scene, they were appalled by the clamour arising from the well-arranged confusion of shouting out addresses of consignments, the chucking of packages across from truck to truck, the enquiries for missing articles, the loading, unloading, and reloading, which his clever device had brought into operation" It was magnificent, and it was war, and it impressed the Commissioners with the vast business carried on by the Birmingham & Gloucester, but it was not fair, and Mr Payne departed to become General Manager of the South Stafford, when, in the following year, 1846, the Midland absorbed the line and secured the Bristol & Gloucester as already related And with the Birmingham & Gloucester the Midland took over the privileges of sharing the Birmingham Station with the North Western, whence both companies use New Street at the present day

The Bristol & Gloucester, owing to a contract, had to remain broad-gauge for some time, and the narrow metals did not get into Temple Meads Station until 1854 In preparation for that event Mr Kirtley in 1848 designed four convertible engines which were really narrow-gauge on broad-gauge axles, and when the road was altered the axles were shortened to suit the width. This idea was adopted by the Great Western when they were preparing for the abandonment of the broad gauge

Hudson's policy of expansion was persistently pursued, and in 1846, the great year of the railway mania, his activity was amazing "Under Mr Hudson's direction," we read, "the shareholders of the Midland Company gave their approval to twenty-six bills which were immediately introduced into Parliament On Monday following, at ten o'clock, the York & North Midland sanctioned six bills, and affirmed various deeds and agreements affecting the Manchester & Leeds and Hull & Selby companies. Fifteen minutes later he induced the Newcastle & Darling-

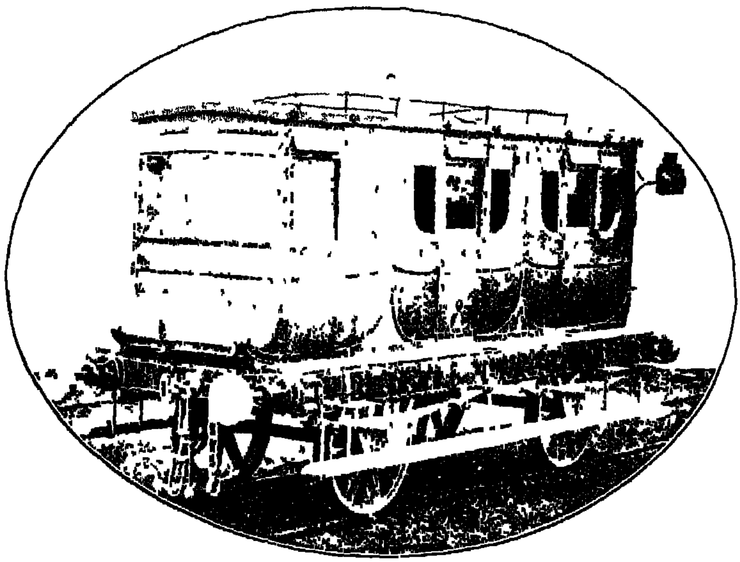
ton Company to approve of seven bills and accompanying agreements, and at half-past ten o'clock took his seat at the board of the Newcastle & Berwick During these two days he obtained approval of forty bills, involving the expenditure of about ten millions"

But he had too many opposing interests to look after, and when he took the chair at the Midland meeting to discuss the purchase of the Leeds & Bradford he was greeted with cries of "You are both buyer and seller!" from supporters of "the Liverpool party" The Bradford & Leeds was bought—it was necessary to buy it, but from that meeting his influence with the Midland shareholders began rapidly to diminish, and when in 1849 "the Liverpool party" obtained the appointment of a committee of investigation, he retired from the line So far as the Midland was concerned he might as well have stayed, for the report of the investigating committee showed that everything was in order and straightforward, but it was not so elsewhere He had done so many things on so many lines that could not be explained away, and he was swept out of railway life in a whirlwind of hatred and derision, to end his days on an annuity of £500 a year

John Ellis, the deputy chairman, who had kept the Midland matters right all through, was his successor, and continued his policy with more discretion, though one of his proposals was of greater magnitude than any that had gone before Seeing that in the near future the company, owing to the increase in its goods and mineral traffic, would have to get direct to London, he proposed in 1852 to amalgamate the Midland with the London & North Western. The scheme was favourably received, and the negotiations proceeded satisfactorily up to the question of terms, when they fell through owing to the North Western, thinking the bargain safe, insisting on deducting fifty shillings per share from the price Ellis had fixed as his minimum

The same year as this failure of the endeavour with

the London & North Western the Midland took over the original North Western, the Little North Western as it was called to distinguish it from the Birmingham line This railway ran from Skipton on the Leeds & Bradford through Settle to Morecambe, with a branch at Clapham, that is the Clapham Junction of the north, to Ingleton It should be noted that the first railway route to Scotland ran over the Midland metals from Rugby to Normanton,

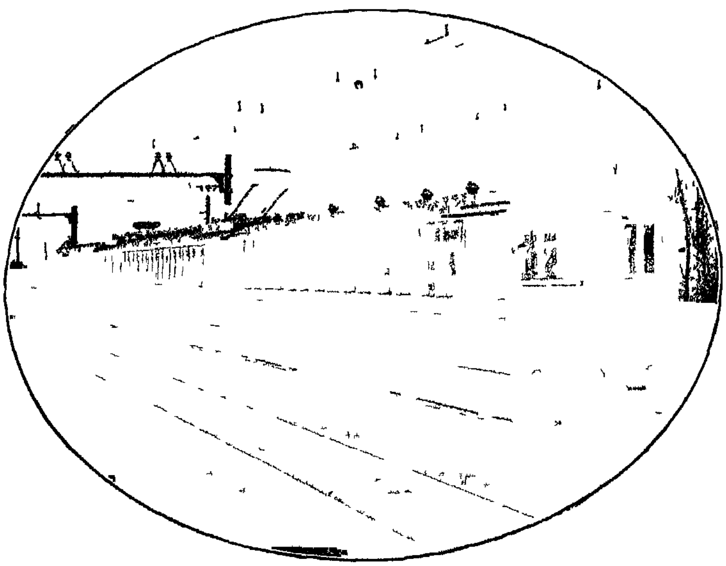


An Old Midland First class Carriage (with Coupé)

whence it went off to York and so on to Berwick, and this taking over of the Little North Western put the Midland once more again on the road to the border by way of Lancaster and Carlisle Further, it gave them the road to the coast which now terminates at Heysham, and, later, by the line from Wennington to Carnforth, it led to the Furness railway which runs from there to Barrow

In August 1852 another attempt at a great amalgama-

tion was made This time the advances came from the other side Within two days the Midland had two proposals, one from the London & North Western, the other from the Great Northern, and the outcome of it all was the Bill introduced into Parliament in 1853 for the combination of the three companies into one Never had there been such a chance of simplification and improvement in our railway system, but the House of Commons



Electric Train—Heysham, Morecambe & Lancaster Branch

rejected the Bill on what was called the national ground that it suited the country's welfare best to have as many railway companies as possible

The expansion of the Midland continued, and the increase of the traffic to the south rendered necessary the line from Leicester to Hitchin by way of Bedford, the contractor for which was Thomas Brassey At Hitchin this joined the Great Northern, by which the trains went to

King's Cross, and on the 1st of February 1858, just before John Ellis retired, the first Midland train ran to London

The next great advance was in February 1867, when, the line through Derbyshire having been extended from New Mills, there was opened the route to Manchester The same year the Act was obtained by the Midland, the Manchester, Sheffield & Lincolnshire, and the Great Northern to jointly purchase several small railways and form the Cheshire Lines Committee, over whose route the Midland runs its trains into Liverpool

Trouble, however, had begun with the Great Northern for the same reason as with the North Western The Midland traffic became too great for the company to accommodate in addition to its own, and whenever there was a crowd in waiting the owners of the line very naturally gave their own trains precedence Protests and disputes were unavoidable, and became so serious that on the 30th of June 1862, a year when 3400 Midland trains were delayed between Hitchin and London, the Great Northern resorted to the extreme measure of evicting the Midland from the sidings at King's Cross, and threw the whole traffic into confusion This brought matters to a crisis, and the Midland replied by obtaining the Act next year which empowered them to continue their own line from Bedford to St Pancras

In making this four-track line the engineer, W H Barlow, had an ordinary task on a large scale, but designing the terminal station was a difficult problem He had to cross the Regent's Canal about half a mile away, going under it meant a low-level station, going over it meant a high-level one He went over it and built the strongest station in the world by putting his platforms in the roof! The ribs of that magnificent arch of 240 ft span can be seen passing down below the floors, the brick walls are merely screens, the offices are in the parapet, and the building that carries the roof is down below The ties

of the roof are the joists of the floor, on which are the platforms and rails , and this floor of nearly four acres is of the same strength all over its area, so that at any time the rails and platforms can be rearranged at will

This is the top floor, the attic so to speak , below is another floor of the same extent, carrying another busy series of rails, and casks in thousands, casks upon casks in such numbers as can be seen nowhere else at one view, it being one immense warehouse used as the store for the Burton beer trade This was the ruling element in the design, for the 720 supports had to be 29 ft 4 in apart, that being the distance found to allow of the largest number of barrels being placed between them , and, as the superstructure had to be built to suit the supports, the unit of the whole fabric was really a barrel of beer Below this floor is the City branch of the line curving from east to west, and running under the canal before it can rise into Camden Town , and in addition to this diagonal tunnel there is a spare tunnel under the front of the hotel in readiness for an increase in the metropolitan traffic, while at a still lower depth below the three levels of rails runs the River Fleet, carefully imprisoned in a sewer on its way to enter the Thames at Blackfriars Bridge

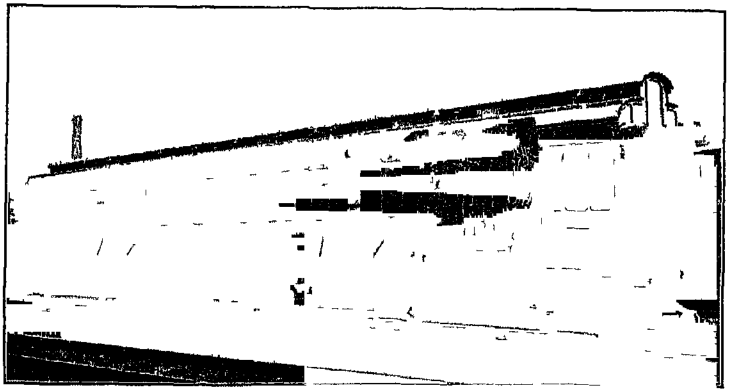
The hotel is the result of an open competition in which the prize was won by Sir Gilbert Scott It is his only hotel, and he is said to have taken part in the competition solely because he found himself detained in London during a holiday season with nothing to do It is a masterpiece , and he is said to have regarded it as the fullest realisation of his own special treatment of Gothic for modern purposes That the station roof is pointed at the crown is a coincidence , that was Barlow's idea, not Scott's, and Barlow adopted it because of its advantages in resisting the lateral pressure of the wind, just as he lessened the radius of curvature at the haunches to give greater headroom near the walls

St Pancras was opened on the 1st of October 1868, Somers Town Goods Station near by having begun business a few months before Since then the Midland has got to Whitecross Street, and the goods traffic has been extended all over the docks district from Mint Street to Tilbury, and all round the south of London to Hither Green, where the sorting sidings are mainly used for the express fruit trains which distribute the Kentish produce from Leicester northwards to Scotland And the passenger trains go farther, for there is one corridor express through from the north to Folkestone, Dover, and Deal

In 1869 the Midland obtained through communication with Wales as far as Brecon over the Hereford, Hay & Brecon In 1876 the Swansea Vale was purchased, and to it the Midland runs over the Neath & Brecon In 1879 the Severn Bridge was opened, giving access to the old Lydney & Lydbrook, which became the Severn & Wye Over this bridge the Midland had running powers, and a line was made to it from Berkeley Junction to Sharpness, the line from Berkeley to Lydbrook being now in the joint ownership of the Midland and the Great Western

The great engineering feature of the Midland is the extension from Settle to Carlisle opened in 1876, by which it obtained its through road to Scotland Seventy-two miles long, with not a patch of ground throughout its length level enough to build a house on, it has viaducts 100 ft high, cuttings 100 ft deep, tunnels for over a mile through every sort of rock, and embankments where the tipping went on for twelve months without advancing a yard Amid snow over 7 ft. thick, at one place imprisoning the engineer and his men for three weeks, rain over 90 in a year, reducing the working days to two or three a week, and wind so strong that the bricklayers could not work on the scaffolds, the making went on for seven years, until it was completed as one of the best lines of railway in the world

In one place it runs through boulder clay hard enough on fine days to require blasting, on wet days a mass of glue with boulders in it of all sizes and hardnesses, that when unexpectedly picked on gave the men such a jar in their arms that many threw down their tools and refused to work any more At Blea Moor, where the line is 1151 ft



Post Office Van, with Net for picking up Mail bags while running at full speed

above sea-level, two thousand men were engaged for over four years on embankment, tunnel, and viaduct The tunnel, through the grit, limestone, and shale of the flank of Whernside, was made by working from both ends and from seven intermediate shafts, some of them 500 ft or more deep, the rock hard enough to stand blasting but not stable enough to be left without a lining, and the dynamite and gun-cotton had all to be carted from Carlisle or Newcastle at a cost of £200 a ton

From Blea Moor the line rises generally to the summit level at Ais Gill, 1167 ft, passing over Fell End Gill, 100 ft below, by the Dent Head viaduct, and then on through Black Moss tunnel and three other tunnels and forty-seven cuttings, and over four other viaducts, one of which is 145 ft. high, sixty-eight road bridges and a

hundred culverts Down from Ais Gill the road is quite as varied, and near Dry Beck it is taken over an embankment containing 400,000 cubic yards "As two and a half or three such yards of stuff" says F S Williams, whose description of the line all should read, "would quite fill a tip wagon, it is plain that at least 133,000 separate journeys had to be taken, and 133,000 such loads had to be filled and emptied, before even this one work could be completed"

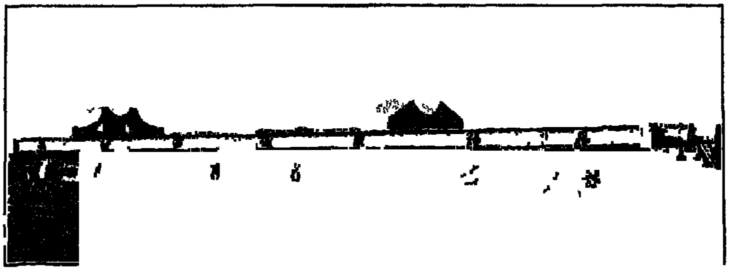
At the curve of the Eden just before High Stand Gill a landslip took place, and five acres of ground began to move, the space between the line and the river blew up, unable to resist the pressure of the embankment, and slid down towards the water It had been known at the outset that this spot would be troublesome, and it had been said that no railway could be carried here But Crossley took the line across the slope, and, though the incline of the bank was 200 ft from top to bottom, and the bank slipped and carried with it trees forty or fifty years old for a distance of 150 ft, driving the river sideways actually into the next parish, the difficulty was overcome Such is the road over mountain and moorland by which the Midland goes through to the north

There is no better permanent way than the Midland, and none better kept The sleepers are rectangular, 9 ft long, 10 in wide, 5 in. thick, and laid 2 78 ft apart from centre to centre, reduced to 2 17 ft where there is a joint between, the 45-ft bullhead rails weigh 100 lb. per yard and the chairs weigh 55 lb each In 1875 the Settle & Carlisle was laid with rails weighing 83 lb to the yard and rolled in 24-ft lengths, but what was good enough then is of no use now, when trains are twice as long and thrice as heavy

The Midland is fortunate in its scenery On the Settle & Carlisle the natural features are on a large scale, and the views, when not in the tunnels and cuttings, are singularly

grand and wild On the North British continuation to Edinburgh, the so-called Waverley route, the landscape becomes more comprehensible and its charms are great, but there is no more picturesque road than that through Derbyshire, where the details of the landscape are just of the right size to be appreciated by the railway traveller

It was for this line to Liverpool that Pullman cars were introduced into this country, the curve at Marple being specially built to suit them The cars arrived in pieces and were put together at Derby On St Patrick's Day 1874 they were used for the first time as a special

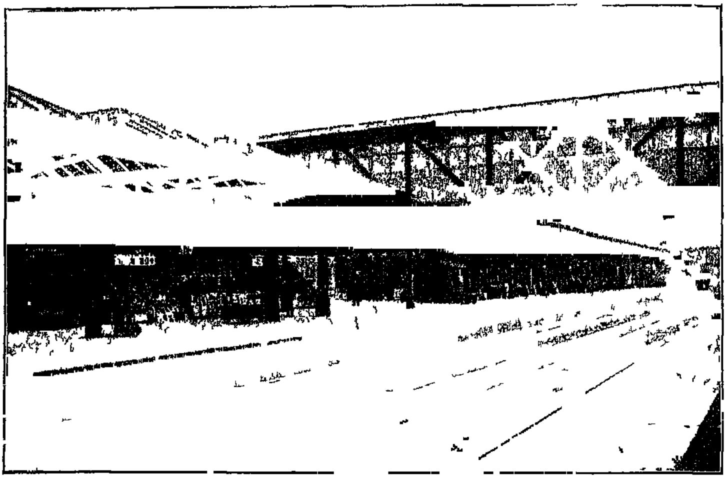


Steel Bogie Truck, specially built for carrying Heavy Guns

train for the officials of the line from Derby to St Pancras, and with two three-minute stops the distance was run in two hours and a half, a speed of 75 miles an hour, the Midland trial speed, being at times attained On the 1st of June the train of five cars began regular running between St. Pancras and Bradford, and on the 1st of April 1875, the Marple curve being ready, they were put on the Liverpool road, and a midnight sleeping-car was run from London to Liverpool in addition

That, however, was not the first sleeping-carriage used on our home railways, for on the 1st of October 1873 the North Western began running on the West Coast route to Glasgow a sleeping-carriage that was 33 feet long. At first it ran on alternate days in the Limited Mail, but other

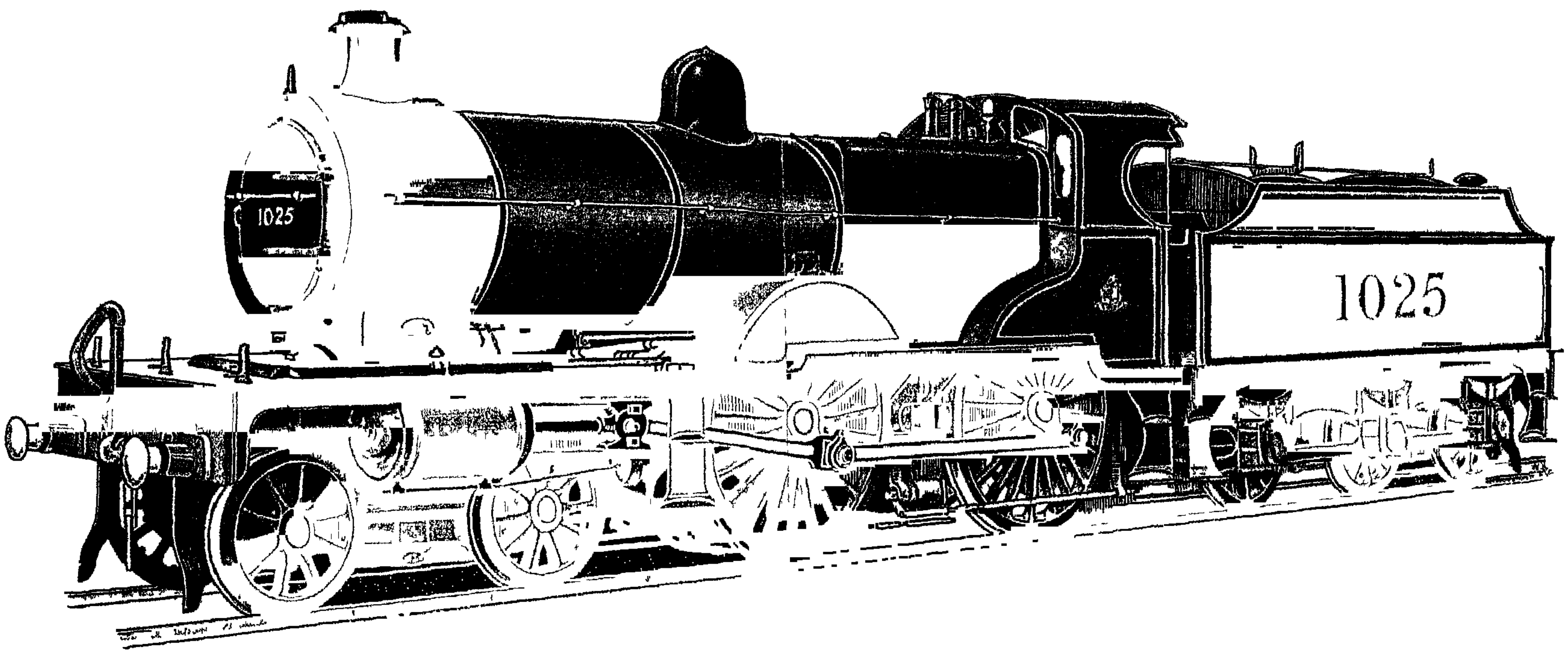
similar sleepers were built and began running daily in each direction on the 1st of February 1874, more than a year before the Pullmans These Pullman cars had a most important influence on our rolling stock At first they were said to be dangerous, but it was soon found that the safest carriage in the train was that behind the Pullman, then that it was no safer than the Pullman itself, and then the smoothness of the running led to



Nottingham Station, No 5 Platform

the introduction of the present style of long carriages with the four-wheeled bogies

The first Pullmans had the buffet or travelling bar, and all the breakfasts, luncheons, dinners, and suppers now served on railway journeys can be traced back to the luncheon served on the Pullman train at the trial trip in 1874 by Spiers & Pond, who came from Melbourne to vastly improve our railway refreshment arrangements, and, beginning with the Metropolitan, had then extended to the Chatham & Dover and Great Eastern, and many of the Midland Stations.



THE MIDLAND RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 1025

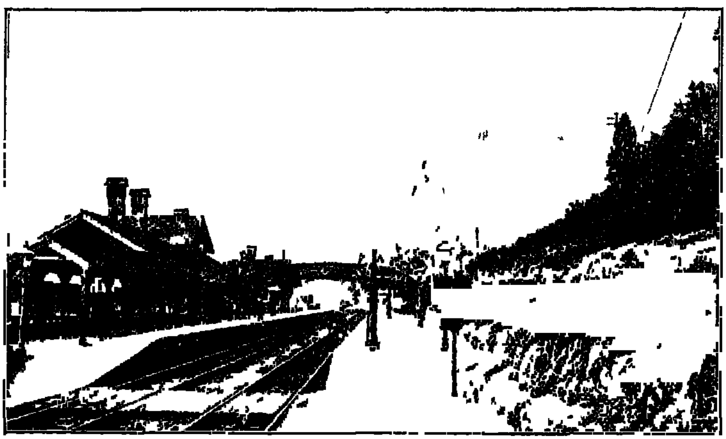
DESIGNED BY MR R M DEELEY M INST C E

BOILER	Length		11′ 11″
	Diameter		4′ 7⅛″
CYLINDERS	Diameter	One H P	19″
		Two L P	21″
	Stroke		26″
TUBES	No		216
FIRE BOX	Length		9′ 0″
	Width		4′ 0½″
HEATING SURFACE	Tubes		1320 sq ft
	Fire box		153 ,,
DIAMETER OF WHEELS	Bogie		3′ 6½″
	Coupled		7′ 0″
GRATE AREA			28 4 sq ft
WORKING PRESSURE			220 lb per sq inch

WEIGHT IN WORKING ORDER		Tons	Cwt	Qrs
	Engine	59	18	0
	Tender	45	18	2
Total	Tons	105	16	2

WATER CAPACITY	3500 galls
COAL CAPACITY	7 tons

At the end of 1874 the Midland had four classes running, the Pullmans, for which extra fares were paid, and the ordinary firsts, seconds, and thirds, but on the 1st of January 1875 the company withdrew the second class amid many prophecies of early bankruptcy Later on in the year, amid another outburst of alarm from the competing companies, who talked of its being "a pampering of the working classes" and "a blow struck at second class



Matlock Bath A typical Station in Derbyshire

throughout the kingdom," the Midland had the temerity to announce that for the future all its third-class carriages would have cushioned seats This was a great reform, the third class of those days being in many instances not much better than packing cases All its second-class carriages became thirds, and an immense number of old thirds were broken up Never before or since was there such a scrapping of obsolete rolling stock, and if some of our other companies, notably in the south, were to follow that heroic example to-day, it would be all the better for them, particularly on suburban lines where they are complaining of the competition of the trams.

Anyhow, let it be remembered that it is to the Midland the public owe third class by all trains and the disappearance of the cushionless thirds on the north-going lines It was the pioneer of fast and cheap travelling, and if, as Mr Acworth said some twenty years ago, "Sir James Allport, in urging his proposals upon the Midland Board, mistook the interest of his shareholders"—which he did not—"there can be no denying that upon the population of the country at large he conferred a boon that entitles him to rank with Rowland Hill as a benefactor of his species"

Allport was the greatest Midland manager He was the Midland personified, the Bismarck of railway policy, the Nunquam Dormio of the line Born at Birmingham in 1811, he became in 1839 chief clerk of the Birmingham & Derby, of which he soon became manager, signalising his term of office by being one of the first to propose the Railway Clearing House system, and taking a conspicuous part in the first battle of railway rates When the amalgamation took place that formed the Midland, Allport was one of those for whom no place was found, and Hudson immediately snapped him up and made him manager of the Newcastle & Darlington, which under him extended into the York, Newcastle & Berwick, for which Robert Stephenson built the High-Level Bridge over the Tyne and the Border Bridge over the Tweed

In 1850 he became General Manager of the Manchester, Sheffield & Lincolnshire, and in October 1853 he was placed in office on the Midland in a similar capacity After four years he retired to manage Palmer's shipbuilding works at Jarrow Within six months, however, he was made a Midland director, and in 1857, being obviously the only man for the post, he returned to the general managership, which he held for twenty years until he became a director again During that score of years the Midland was in the forefront of railway progress Backed up from 1873 to 1879 by one of the best of chairmen, Mr

E S Ellis, whom he succeeded on the Board, he made the Midland great by showing what a great railway could do

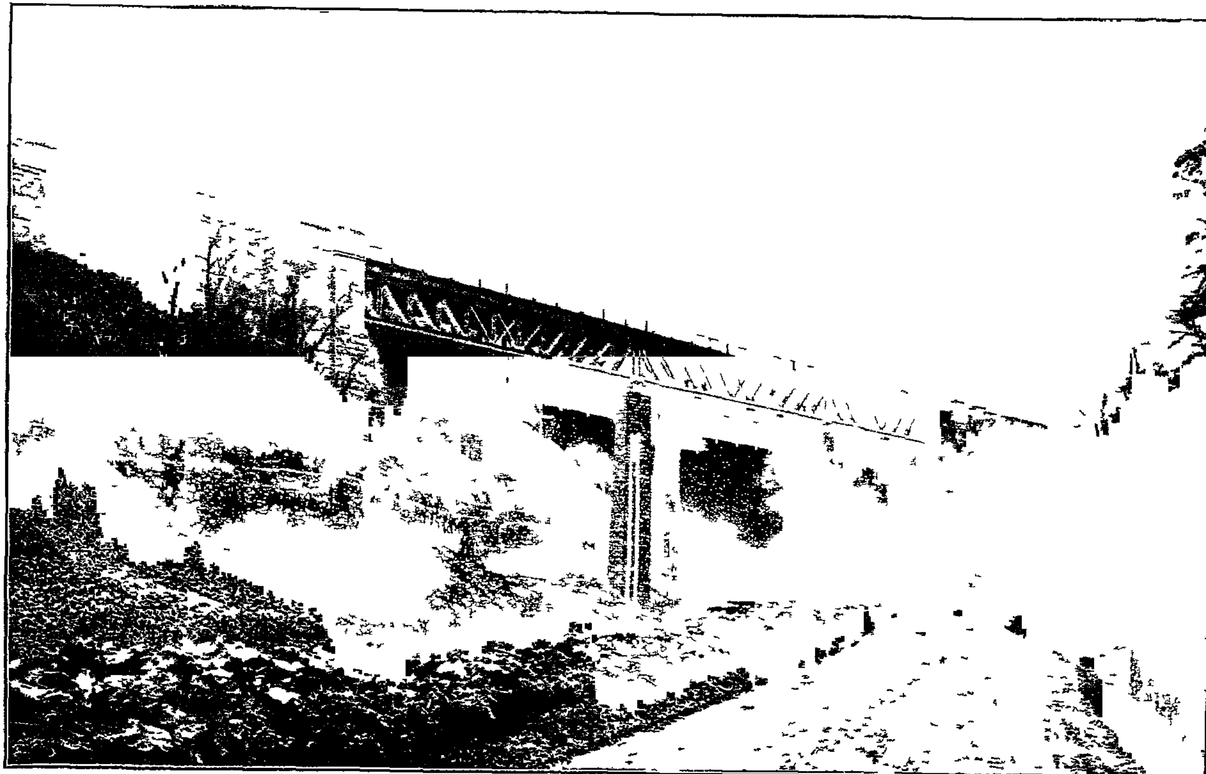
He took the line from London to Carlisle, and he also took it to the Channel In 1874 the Evercreech route was opened from Bath, whence, by the Somerset & Dorset, which it owns jointly with the London & South Western, the Midland reaches Poole and Bournemouth In 1879, by a joint line with the North Eastern to Knottingley, it began to run its trains into York, and in 1893 it became owners with the Great Northern of the Eastern & Midlands, making it the Midland & Great Northern Joint, and so reached the North Sea from Cromer down to Lowestoft Next year it opened the Dore & Chinley branch, giving shorter communication between Sheffield and Manchester, a line of twenty miles of which more than a quarter is through tunnels, on it being Totley, between the valleys of the Sheaf and the Derwent, the longest of our land tunnels, its length being 6230 yards, that is over three miles and a half, only 1446 yards shorter than the Severn, which is our longest river tunnel

Even in these days of tube railways the question of the length of our tunnels frequently arises, and it may as well be dealt with here There are two more which are over three miles long, these being Standedge on the North Western, a triple tunnel measuring 3 miles 62 yards, and Woodhead on the Great Central, a double tunnel measuring 3 miles 27 yards There are five whose length is over two miles—Chipping Sodbury, on the Great Western, which is 2 miles 913 yards, Disley, near New Mills on the Midland, which is 2 miles 346 yards, Bramhope, between Leeds and Harrogate on the North Eastern, which is 2 miles 225 yards; Festiniog, on the North Western, which is 2 miles 206 yards, and Cowburn, on the Dore & Chinley branch of the Midland, which is 2 miles 182 yards There are more than thirty others over a mile in length, and these are much too numerous to mention

In railway making the first to come is the best served, hence the older the line the easier the road On the Midland this is clearly shown, in its own special territory its roads are worked easily and cheaply, but the extensions it has not obtained by amalgamation and has had to build are nothing like so economical The North Western coming from the north chose the best route, the Great Northern coming next took the next best, the Midland came third and took the best available Hence it is more difficult into London than the other two, as it is into Scotland, as might be guessed from its picturesqueness, for the picturesque means the hill and dale an engine-builder would rather do without

The steepest gradient used by our expresses is, as we have seen, the inch in a yard at Bromsgrove, George Stephenson refused to lay out any incline for engines to work up steeper than 1 in 330, that is 16 ft in a mile, roughly speaking an inch in nine yards To find such a low gradient as this on the Midland road to Carlisle you have to go as far as Leicester in its old territory, where a run of some twenty miles at 1 in 300 takes you down to Trent For ten miles about Staveley you get 1 in 330, and just past Appleby there is a short stretch of 1 in 440, and that is all

Leaving St Pancras, you begin to rise until, up slopes of 192 and 196, you reach Hendon, and at 176 pass Elstree with a 200 down to Radlett and 173 up to St Albans Thence a 200 takes you to Harpenden, and a 300 from Luton ends at Leagrave, where you are 367 ft above St Pancras Downhill at 200 takes you to Bedford, whence, after crossing the Ouse seven times, passing Oakley and running over the water-troughs, you rise at 120 to Sharnbrook, and go down at the same slope to Wellingborough Rising at 161 to Kettering, the gradient becomes 132 up to Desborough, 435 ft, and you run down a similar bank to Harborough, to rise at it again to Kibworth, and then begin the thirty miles downhill to Trent. For some dis-



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THE MILLER'S DALE VIADUCT

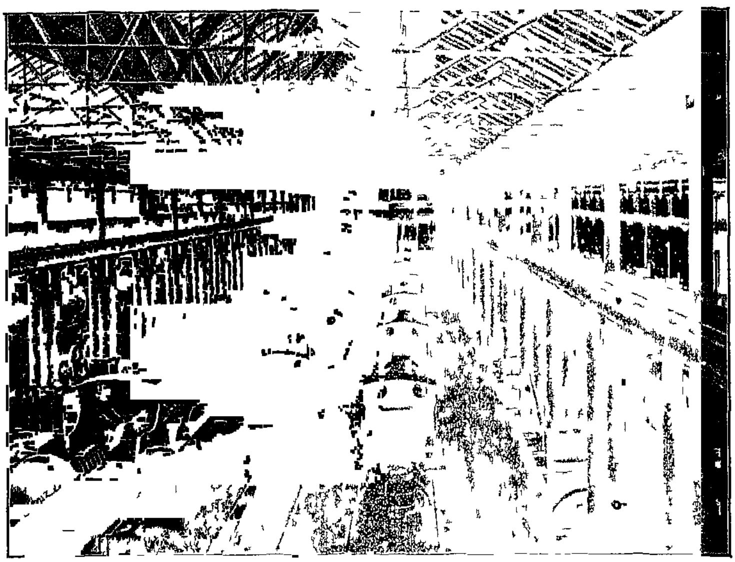
tance the line is practically level, and then, with 150 and 230, you climb to Alfreton, and at 160 go down to Clay Cross, and so, with the gradients easing all the way, to Cudworth From here you rise over a low hill to Normanton and Hunslet, whence you go up at 213 to Shipley and more sharply to Keighley, down for a little at 247 and up at 200 and 190 and down at 181 to Hellifield Up you go again at 100 through Settle to Blea Moor, down a little at 286 and, at 185, up to the summit level at Ais Gill, where you are 252 ft higher than the summit level of the North Western at Shap From Ais Gill you run down to Ormside at 100, and, with two short rises, descend to Carlisle at 440, 132, 264, 132, and 200

The work of the Midland engines on the Scottish expresses is a sufficient testimony to their power and speed Comparisons between the engines of different companies based on their booked times are simply misleading If engines were ever to be raced hauling the trains they were designed for, the engine that ran on its own line would probably win—with a few exceptions, of course that need not be mentioned as none of the obvious offenders run to the north Engines are built to suit conditions When new they are good enough for their work, and they go out of date by the increase of the traffic putting more work on them than they were designed for

American engines were first imported from the United States in 1839 by a company soon after absorbed by the Midland, and history repeated itself sixty years afterwards when the Midland put on its rails the thirty from Baldwin's and the ten from Schenectady that had to be obtained in a hurry owing to a press of locomotive work in this country The Baldwins had outside cylinders 18 in in diameter with a 24 in stroke and 6-coupled 60-in wheels, the leading wheels being 33 in carried in a pony frame, a pony being a two-wheeled bogie The old Norris engines weighed 8 tons, the Baldwins, like

the Schenectadies, were about the square of that weight One distinguishing feature they had which was noticed by every one, the roomy, comfortable cab which compared so favourably with that of the usual Midland type

These were, and are, of some interest among goods engines, but the most interesting engines now on the line are the handsome, workmanlike Smith compounds used on the

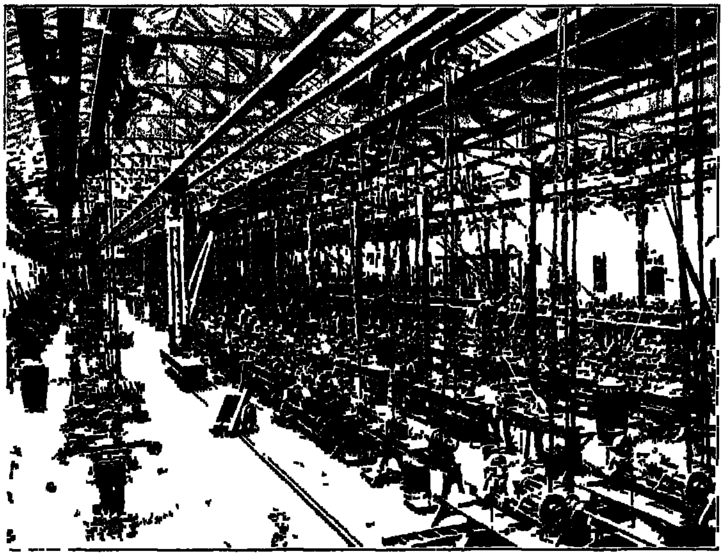


The Midland Works at Derby—Part of the Engine Erecting Shop

Scottish expresses between Hellifield and Carlisle These have a high-pressure cylinder inside of 19 in in diameter, and two low-pressure cylinders outside of 21 in, the stroke being 26 as usual They have a heating surface of 1458 sq ft, and are fitted with the Belpaire firebox which the Midland adopted after the Great Western led the way

In a simple engine the steam is used at high pressure only, in a compound it does work at high pressure and is then passed on to do another turn of work at low pressure The first compound locomotive seems to have been in-

vented in 1850 by John Nicholson, one of the Eastern Counties drivers, and patented by James Samuel (No 13,029), and in 1852 two engines were rebuilt on that plan at Stratford, one being a passenger engine and the other a goods They had two cylinders of equal size, worked alternately as first and second in what may be described as a series of continuous expansion The high-pressure



The Machine Shop—Midland Works, Derby

steam entered the first for half the stroke, then expanded in the upper half of the first and the lower half of the second, and passed out, while the upper half of the second received high-pressure steam to be expanded in turn in the lower half of the second cylinder and the upper half of the first

Since then the compound engine has appeared in too many forms to be mentioned here Among the most important are T W Worsdell's, in which are two cylinders, one larger than the other, placed either inside or outside

the frames, one of this class being No 117, that did the last and fastest run to Scotland in the great railway race of 1888 under a pressure of 170, working up to 76½ miles an hour and averaging over 57 miles an hour from York to Edinburgh Mr Worsdell began compounding when at Stratford, and when he left all his engines on that system were converted into simples by Mr Holden, and most of his compounds on the North Eastern have been similarly converted by Mr Wilson Worsdell, whose latest compounds have four cylinders, two high and two low, on the Smith system

Then there are F W Webb's compounds, at first with three cylinders, the low-pressure one between the frames with its base prominent in front, and later with four cylinders, the two high-pressure outside the two low-pressure inside These drove one axle with the cranks at ninety degrees, while in the 3-cylinder ones for passengers the low-pressure drove one pair of wheels and the high-pressures drove another pair, and the three cylinders for mineral work were 8-coupled engines driven on one axle And just as Mr Worsdell's compounds were not gone on with at Stratford and Gateshead, so Mr Webb's were discontinued at Crewe

Then we have the compounds invented by Mr Vauclain of the Baldwin Company, and the Mallets begun with the Bayonne & Biarritz in 1874, and now developed in the huge "articulated" engine, an engine so named being one in which the cylinders work on distinct sets of coupled wheels, to divide it into two driving sections capable of independent movement along curved lines notwithstanding the length of the wheel base And there are the De Glehns, of which the Great Western has three, in which the separate cylinders drive on separate axles, the high-pressures driving the trailers, and the low-pressures, placed well forward inside, driving the leaders, all four cranks being at right angles to one another In the De Glehns the low-pressures can get steam direct from the boiler if required, and the

same idea is a prominent feature in the system invented by Walter Mackenzie Smith, the first locomotive engineer that went to Japan

There are some of his engines on the North Eastern and Great Central, but the Midland has a large class of them In them the three cylinders drive one axle, the low-pressure cranks being ninety degrees apart and the high-pressure dividing the obtuse angle The engine starts as a non-compound and changes to a compound as soon

The Midland Goods Depôt at Birmingham

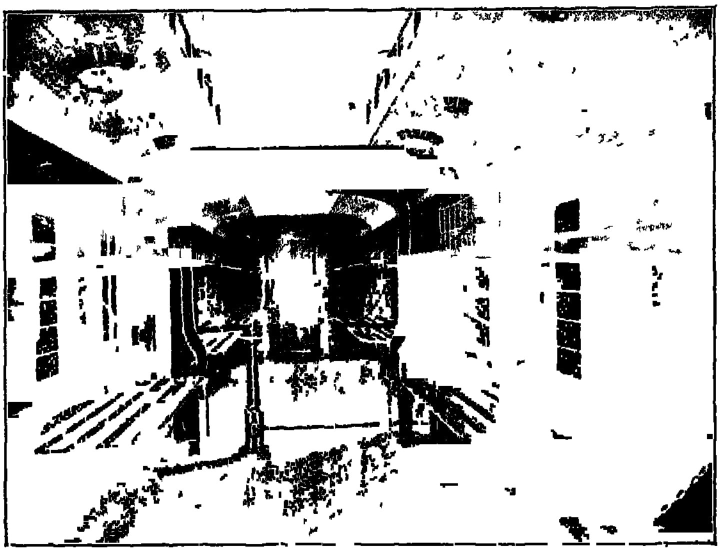
as there is enough pressure in the receiver from the exhaust of the high-pressure, the automatic valve changing the engine back to non-compound as soon as the pressure is inadequate Another valve allows the driver to admit steam into the receiver sufficient to start compounding, and also to supply steam when necessary to the low-pressure Thus the engine can be worked as a 3-cylinder simple, as a 3-cylinder compound, as a compound with low-pressure steam reinforced, and as a 2-cylinder simple with a large cylinder, the high-pressure piston " floating " as it is called

According to Mr Deeley these compounds take rather heavier loads than the simple engines, and on the ton-mile basis the economy of the compound as regards coal is 7¾ per cent better than the simple To this must be added the saving resulting from the much less double heading required The greater duty which can be obtained by the compound, as regards weight of train hauled, is due to the fact that the blast-pipe orifice can be made small enough to give a fierce draught without checking the engine as regards speed With a larger blast-pipe orifice he has found that they work the lighter trains even more economically. Some of them are now fitted with a variable blast pipe, and much better all-round results have been obtained, as regards fuel consumption, with its assistance, 7¾ per cent may not seem a large saving to effect, but when the great cost of coal to a railway company is considered, it is really a very considerable economy to secure in addition to obtaining a light engine of great hauling power

Compounds can work at much higher pressures than simples that have only two cylinders, and to this much of their success has been ascribed These Midland engines work at 220, but a 4-cylinder simple can stand a pressure of that amount, and the opponents of compounding seem to be as unconvinced as they have been for the last fifty years, and enlarge on this and on the slipping and difficulties of starting, and other details of handling which are reduced to a minimum in the Smith engines

There is no mistaking a Midland engine in these days, and the company are doing their best to impress its number on the memory by the tender figures, in fact the tenders seem to be built larger in order to carry the figures But Midland things are mostly large For instance, there are some 40-ton coal trucks at work that look big enough for anything, and the new 6-coupled goods engines seem big enough and powerful enough to haul any length of train of

them It has a vast mineral traffic, thirty-eight million tons a year, which it works as well as any company, and it has a general merchandise account of over nine million tons which it handles better than all It is in this miscellaneous goods work that it has excelled ever since it came to London Nothing seems too small, nothing too mixed, nothing too large, that it cannot collect and deliver with despatch



A Guard's Van fitted up for Pigeon Flying Traffic
The birds are liberated at various points while the train is travelling.

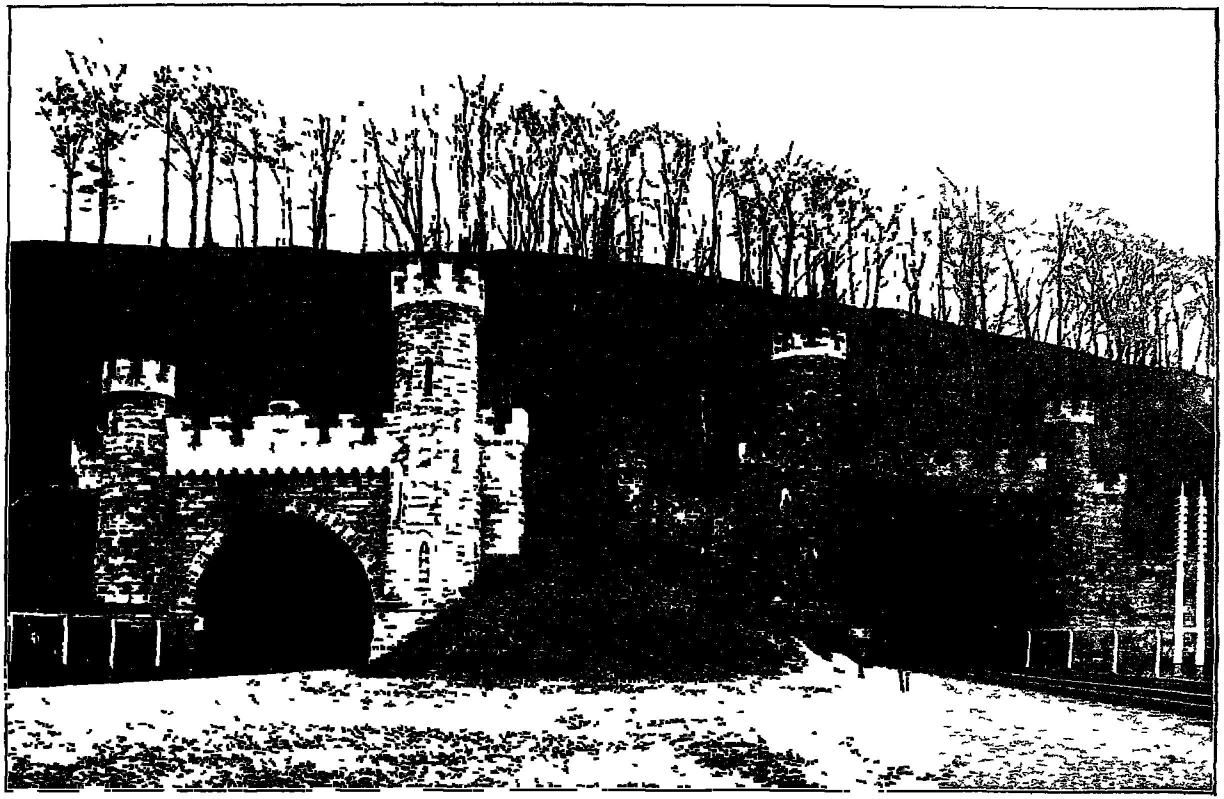
It may be bridges or great guns, straw hats or steam boilers, they all come alike to it. It even runs pigeon-vans, fitted up for homers, which it takes from Manchester or elsewhere to let them loose wherever ordered, or, for the long distance championship, stage by stage to Southampton, whence the birds go on to St Malo to be released on French soil and fly away home And it works quite another sort of flitting, that of the touring theatrical companies, whom it takes on Sundays from anywhere to

anywhere all over the country, all of it, of course, arising from its through excursion business

The Midland engines were among the first to have a leading bogie, the bogie being that little truck with a large central, or sub-central, cushion and sliding supports at the four corners which is carried by the four small wheels Before it was revived in this country after the arrival of the Pullman cars, the difficulty of working round curves was got over by radiating axles, the best known pattern being that invented by Bridges Adams in 1861, in which the result was obtained by shaping the boxes and horn-blocks to arcs of a circle and allowing the axles to slide endways so as to assume a position approximately radial to the curve

The radial axle-box is obsolete, but its ingenious inventor is represented on every railway track in the world by a simple thing that solved what every one else had given up as insoluble This is the fish plate invented by him in 1847, which not only gave a perfect joint but imparted a much greater degree of elasticity to the permanent way than the old joint-chair in which the ends of the rails were keyed In keying a rail one would hardly suppose there would be room for difference of opinion, but such existed for many years after the introduction of the wooden key on the Grand Junction by Joseph Locke, and only since 1884 has the Midland put its keys outside

The more the population increases the greater need there is for increase in the means of communication, not only for those who travel about, but for food and clothing and other necessaries Every year, therefore, the railways find more work to do, just as they are more hindered by the Government in doing it This increase of work is most apparent to the multitude in the enlargement of stations, which may or may not be in excess of any probable traffic in certain suburban areas But a more trustworthy indication is in the enlargement of the locomotive



REDHILL TUNNELS, NEAR TRENT

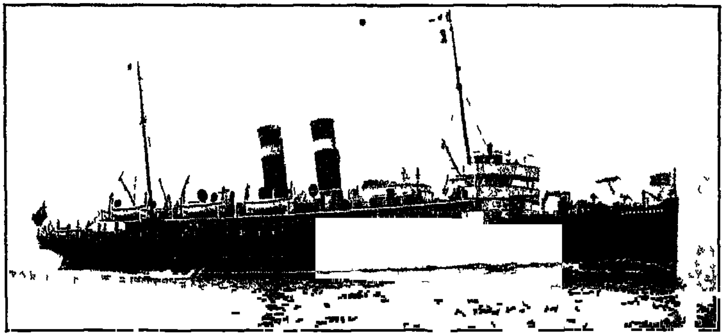
and carriage works on which the system depends The growth of these centres of industry is in most cases continuous, either in the increase of their area or in the crowding of the site with greater facilities

At Derby it has just been the turn for the carriage and wagon works to be enlarged A new carriage lifting shop has been put in 580 ft long by 200 ft wide, divided by rows of triple steel stanchions that carry the runway girders of the 15-ton travelling cranes which, with the smaller cranes at the sides, serve the twelve lines that run

Entrance to Heysham Harbour

the full length of the floor A new shop for the stamping machinery has also been erected, 100 ft square, and there is a new pattern store "capable of extension" even in these days of standardisation These works, with their mass of wonderful machinery dealing with metal and wood and fabrics and paint, and whatever goes to the making of a railway vehicle, are perhaps more attractive to most people than the locomotive works They reveal the innumerable things a railway has to do, and the tour of them ends in something worth looking at—a Midland train ready for its first run, and there is no greater triumph of coachbuilding.

"How beautifully it is painted! How many coats are there on it?" "Well, madam, there are seventeen." Seventeen! And here they are The first coat is a mixture of three parts of gold-size and one of turpentine to neutralise the greasy matter in the teak wood Then comes a coat of oil, lead-colour, well rubbed in, this being followed by a second coat of the same Then comes a coat of filling, then the holes and uneven parts are made up with hard stopping of white lead, gold-size, and turpentine, then another coat of filling, pumiced off when hard, then

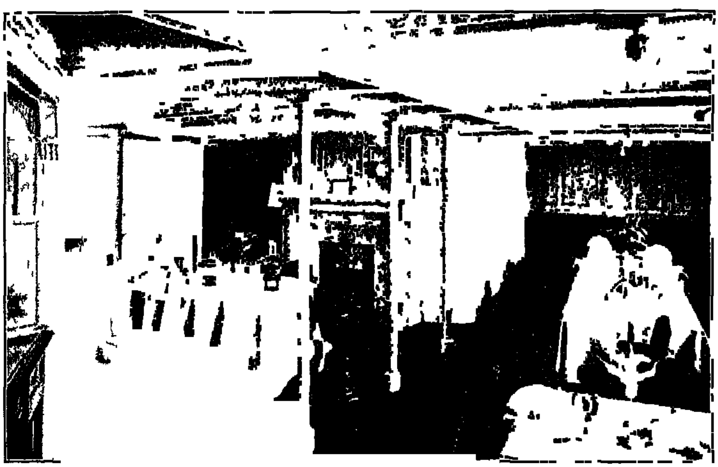


Midland Steamer *Londonderry*—Irish Service

another coat of filling pumiced off in the same way, then a fourth coat of filling, left for some time to harden before it is rubbed down Next comes a coat of lead-colour which is stopped with the finishing colour touched over with the lead This is sandpapered off and the preparatory colour put on Now comes a coat of solid colour, followed by a coat of varnish colour, three parts varnish Then this is flatted, and the lines are put in, and it is varnished, flatted, and lettered, and the coat of arms put on, varnished, flatted, varnished hard and varnished again—and there you are!

In 1903 the Midland added to its hopes and responsibilities by absorbing the Belfast & Northern Counties

Railway, and in 1906 it joined with the Great Northern of Ireland in taking over the County of Donegal lines Much of this property is of 5 ft 3 in, the Irish national gauge, some of it is of 3-ft gauge, and most of it extends over the north-east of Ireland, including all the favourite tourist resorts of the dry corner, and as vigorously as it can it is developing this Irish estate, which can be reached

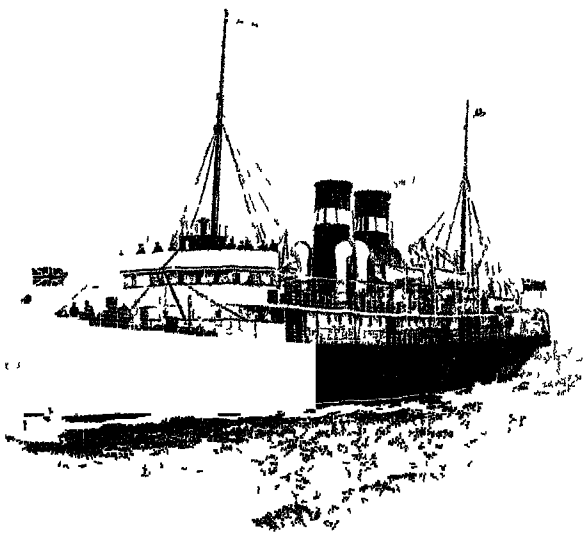


Dining Saloon of the Midland Steamer *Antrim*

by Stranraer and Larne, though the main route is that to Belfast through Heysham

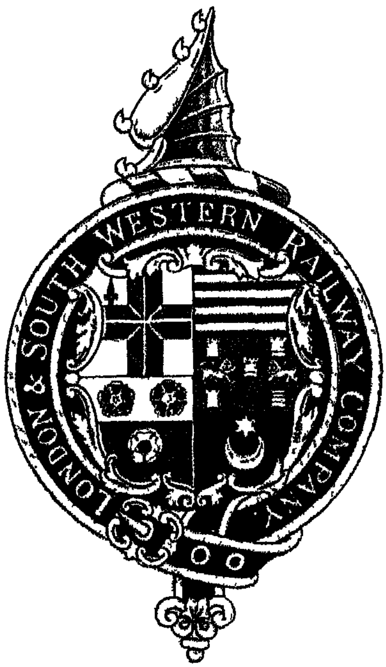
Heysham communicates with Morecambe and Lancaster by an electric line of some interest, the first "single phase" railway in Britain It is a natural port protected by two concrete breakwaters a mile and a half apart at the shore and approaching within 300 yards at the other end, so as to enclose an area of a hundred and fifty acres Here everything of the best has been prepared for a large business in passengers and merchandise, mainly dairy produce and horses, cattle, etc, for which there are stables and lairs and stockyards and pens, and also paddocks for

grazing and resting after the sea passage Altogether a bold enterprise that may be mainly dependent on dredger work, although Heysham Lake is said to have retained its contour ever since it was first surveyed Coasting steamers and small craft are expected to make much use of the harbour, besides the four fine steamers that represent the Midland fleet, the *Antrim* and *Donegal*, and the two faster boats, the *Londonderry* and *Manxman*, the first of which is driven by Parsons turbines, the other having De Laval turbines These not only run to Ireland but to the Isle of Man, like the other Midland boats, the *Duchess of Devonshire*, the *Duchess of Buccleuch*, and the *City of Belfast*, which, however, work from Barrow-in-Furness and not from Heysham

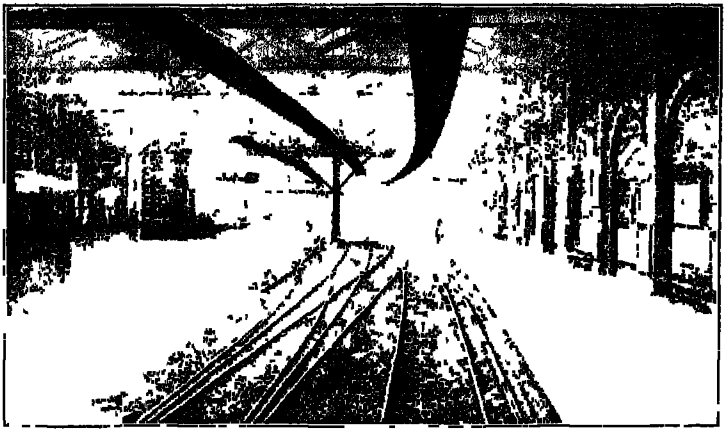


Midland Steamer *Manxman*—Heysham and Isle of Man Service

THE LONDON & SOUTH WESTERN



CREST &
COAT-OF-ARMS



The Main Line Departure Platforms at Waterloo

THE LONDON & SOUTH WESTERN

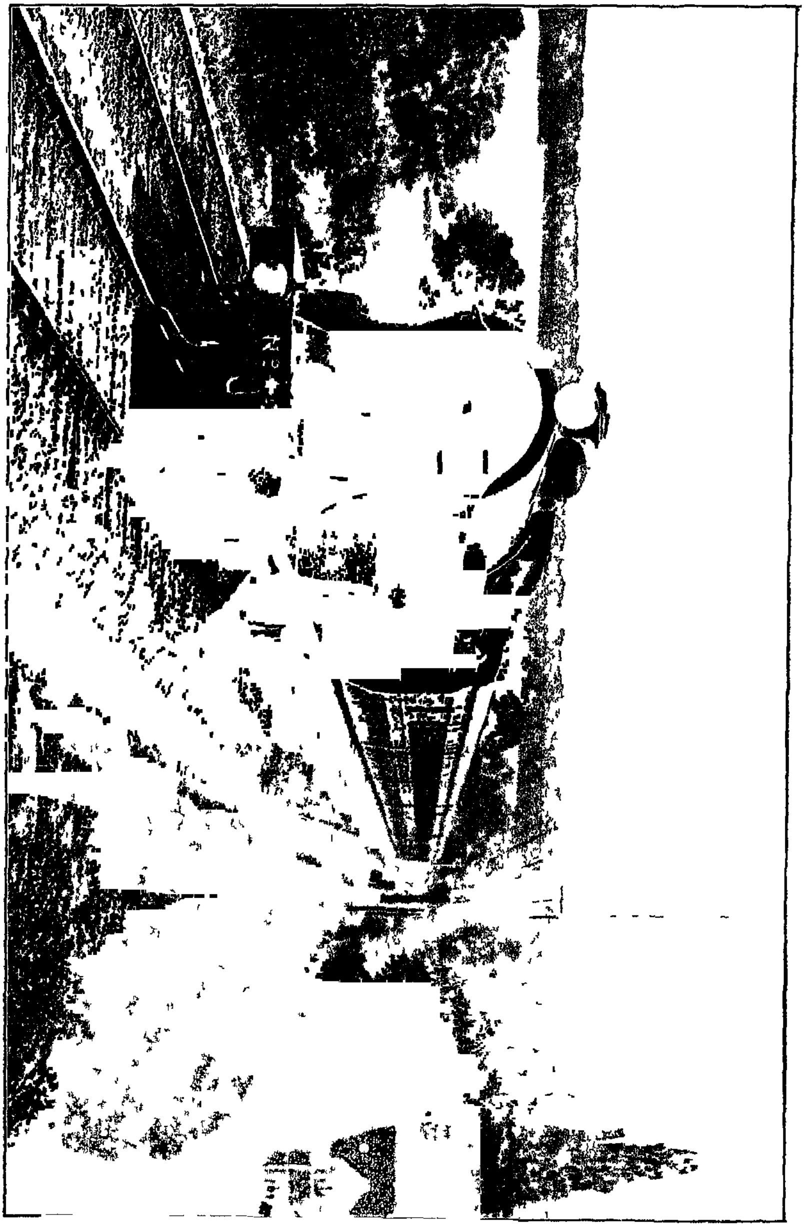
THE South Western—for so it is always called notwithstanding the other South Western over the Border—has been associated with Southampton from the beginning The insecurity of the Channel, even after Trafalgar, had clearly shown the advisability of an inland route to London to avoid a sea passage at the mercy of an enemy's cruisers and privateers, and it is not to be wondered at that in the days of canals a canal was projected But fortunately little was done The London end, the Grand Surrey, stopped at Camberwell, and when another start was about to be made railways had begun to pay, and the canal gave place to the London & Southampton Railway

It was the shipowners of Southampton who put the company afloat Seeing in 1830 what the Liverpool & Manchester was likely to do for the shipping of Liverpool, they talked matters over together, and in April 1831 there appeared the prospectus of—notice the signifi-

cance of the title—the Southampton, London, and Branch Railway and Dock Company As enough money could not be raised for this, a meeting was held in London at which the dock part of the scheme was abandoned, to become a separate enterprise, thereby reducing the capital by half a million, and in the session of 1832 a Bill was introduced into Parliament for the construction of the London & Southampton Railway, which was thrown out. Next year it met with a similar fate, but in 1834 the promoters were more fortunate, and at a cost of £31,000 for legal expenses the Act was obtained, the capital being one million with a third as much in loans—and it was nearly all spent in two years

Had the route been direct much money would have been saved, but it went almost due west from Woking to Basingstoke, with the intention of throwing off a branch to Bristol, and this aroused the hostility of the Great Western people, who did their best to prove the embankments so huge and the gradients so steep that the line could never be made or worked The engineer was Francis Giles, who had surveyed for Rennie's Portsmouth canal, and who when the Liverpool & Manchester Bill was before Parliament gave evidence that "No engineer in his senses would go through Chat Moss if he wanted to make a railway from Liverpool to Manchester" When the Southampton Bill was before the House the Great Western called George Stephenson on their side, who promptly had his revenge with "No engineer in his senses would go through Basingstoke if he wanted to make a railway from London to Southampton!" But as Giles had been mistaken, so was "Old George"

Giles had to get through the Hampshire ridge, and he ran the line at so high a level to avoid as many long tunnels as he could The earthworks were tremendous for those days, sixteen million cubic yards of them, and there were difficulties of many kinds, not the least being that the



work had been let out to small contractors, who obtained payments on account and cleared off as soon as the contract ceased to pay them. There was practically no progress, and matters came to a crisis. Many of the shareholders were Lancashire men,—"the Liverpool party" of the South Western, in fact,—and these, after bringing about the resignation of Giles, put Joseph Locke of the Grand Junction in his place, who called in his friend Thomas Brassey, and in their capable hands the construction went steadily on. This was Brassey's coming to London. He was then thirty-one, and the contract for the portion between Basingstoke and Winchester, and other parts of the line, was his first big job. With it he commenced a career which was to take him railway-making over a large part of Europe, India, and Canada.

The terminus was at Nine Elms, the present goods yard, so placed by the bank of the river as to secure a share of the barge-borne trade of the port of London. The first station, called Wandsworth, was really in Battersea, being—according to the map at South Kensington—on the north side of the road where Battersea Rise ends at what is now the Freemason bridge. The Brighton line, running along the site, bears away just at the spot, and on the other side of the road that company in 1856 built a passenger station, now used for goods only, which, to distinguish it from the old one, was called New Wandsworth and gave the name to the district. At Earlsfield, skirting the east side of Garratt Lane, just before crossing the Wandle, the line went over the old Surrey Iron Railway to Croydon, Wimbledon was the second station from Nine Elms, then came Kingston—at Surbiton—placed so far away from the town that Surbiton was known facetiously for years as Kingston-upon-Railway, until, in fact, the present Kingston Station was opened on the loop line. Next came Ditton Marsh—now Esher—then Walton, then Weybridge, then Woking Common, the

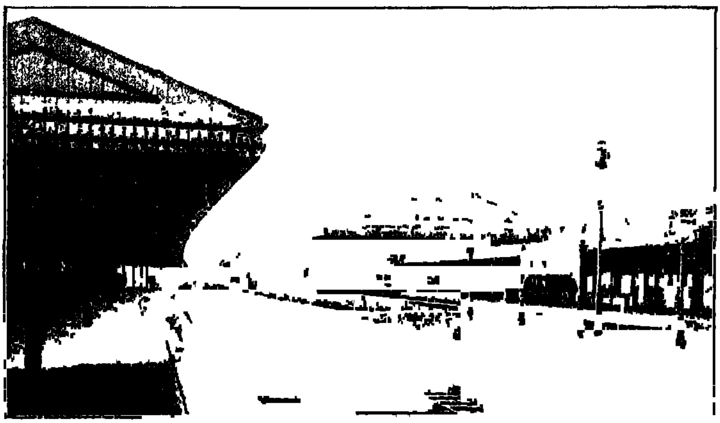
present Woking, to which the line was opened on the 12th of May 1838

Meanwhile work was in progress on the way to Shapley Heath, now Winchfield, and at the other end between Southampton and Winchester Beyond Woking the task was heavy owing to the cuttings and embankments, and beyond Farnborough there was Fleet Pond to be crossed along the sandbank faced with turf, thatched with hazels, pinned with willows, and edged with chalk The line still rising went on to its summit level at Litchfield, 392 ft, and then ran down through the tunnels and under the canal to Basingstoke In June 1839 trains began to run from London to Basingstoke and from Southampton to Winchester, a coach ride filling up the gap until May 1840, when the first train ran through to Southampton The works had cost over two millions, more than double Giles's estimate, much of it raised by issuing the £50 shares at half price

The first branch was to Gosport from Bishopstoke, now Eastleigh This was easily arranged Portsmouth wanted a railway, but would have nothing to do with anything bearing the detested name of the rival port At the same time it was evident that a branch from the existing line would give much cheaper access to London than an independent one all the way that would cost a fortune in legal expenses to get sanctioned by Parliament Could nothing be done? "Is it our name only you object to?" asked the Southampton directors. "That is all" "Well, then, that can be settled at once Instead of the London & Southampton we will call our line the London & South Western" And the Portsmouth people were delighted, the Gosport branch was made, and the railway took the name we know it by

It might be called the recreation line, for what with its nine racecourses, and the Thames boating and reviews and sundries, it makes more out of sport and pleasure than

any other And it began early The first chairman was Sir John Easthope, a successful stockbroker, proprietor of *The Morning Chronicle*, etc , whose breezy, interfering ways were quite a feature of all the small stations on the road to Weybridge, where he lived As he added racing to his other interests there was nothing surprising in the new railway announcing that on the Derby Day, eighteen days after the opening, eight trains would run from Nine Elms to Kingston—Surbiton—for the convenience of the



Basingstoke—the junction of the two main routes

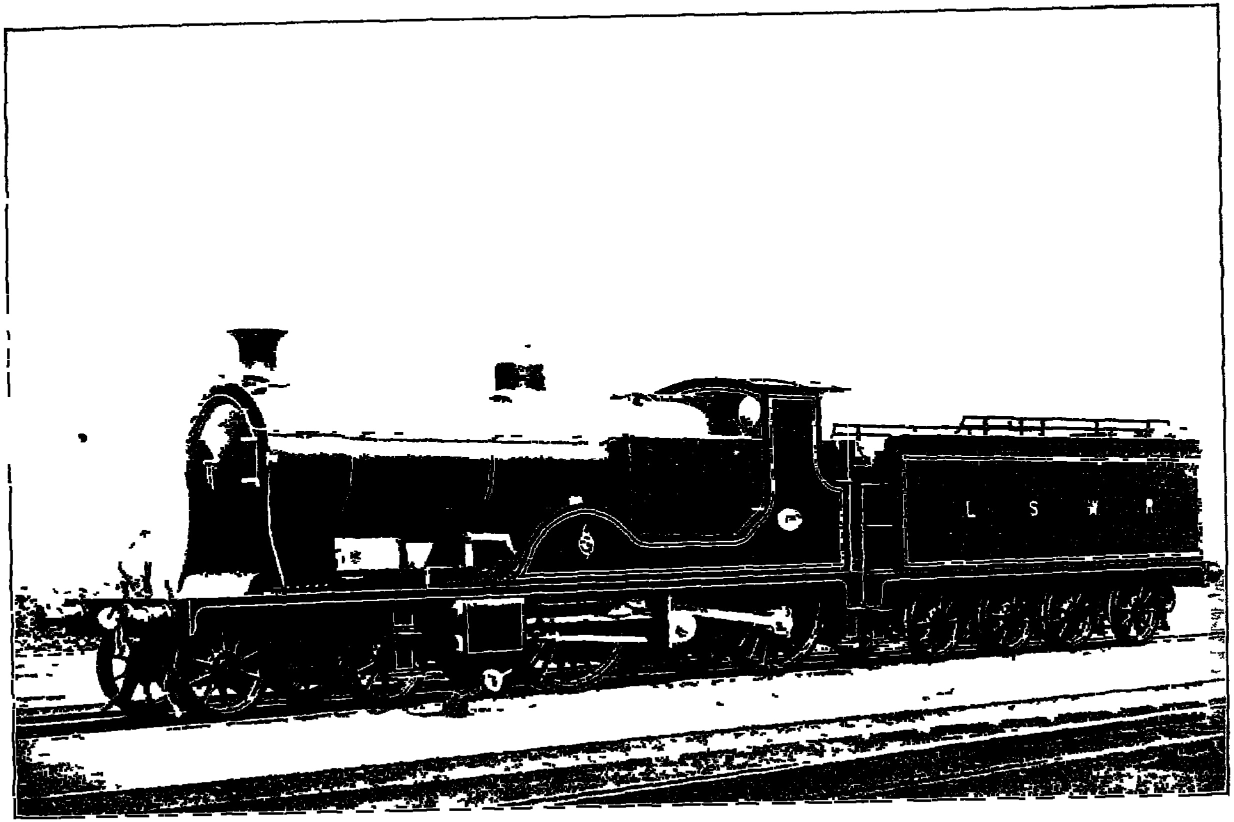
public, who could walk the rest of the way to Epsom The idea does not seem attractive to us now, but things have changed So pleased were the people at the opportunity that they swarmed down to Nine Elms early in the morning and formed a crowd of 5000, who, not being prepared for, carried the station doors off their hinges, took possession of the platform — which was 15 in high — filled all the carriages in sight, and after doing much damage had to be cleared off by the police If this was not an indication of the need of a branch to Epsom, Sir John had never heard of another, and so the Epsom branch was

the first to be proposed 'But unfortunately the forefathers of the Brighton, the London & Croydon, had also their eyes on Epsom, to proceed there atmospherically, and they brought in an opposition Bill which met with Parliament's approval while the other did not Their atmospheric road remained in the air, and for some time the Derby and Oaks patrons, more amply provided for, went to the Downs and back by way of Surbiton

Thus the Gosport branch was the first to be opened, the next being that to Guildford, bought from another company who were going to lay it with wooden rails The next was that to Richmond, afterwards extended to Windsor, which was reached in December 1849 This branch went off just before the first cutting, now known as Clapham Cutting, and in making this cutting, springs were dug into which flooded the excavation, and, to work the pumps for clearing it, the engineer built the windmill which still stands, without its arms, overlooking Wandsworth Common

A new station was built near Falcon Lane, taking the place of the so-called Wandsworth, and to be called Battersea, or rather Battersea Junction But the name was changed to Clapham Junction, why is a mystery, unless we accept the usual explanation that it sounded more important, for it is very much in Battersea and over a mile from Clapham, to which a branch was never proposed On this Richmond branch, opened in 1846, the first station was the Wandsworth, now known as Wandsworth Town, a little farther on, close to the Wandle, the line crossed the Surrey Iron Railway to Croydon, as the main line had crossed it at Earlsfield, and as the South Western bought it just as the Brighton bought the extension from Croydon to Merstham, that old railway ceased to exist on the 31st of August of that year The next branch was to Salisbury from Eastleigh through Romsey, and the next that to Hungerford Bridge

The last was the most costly and best of all, though



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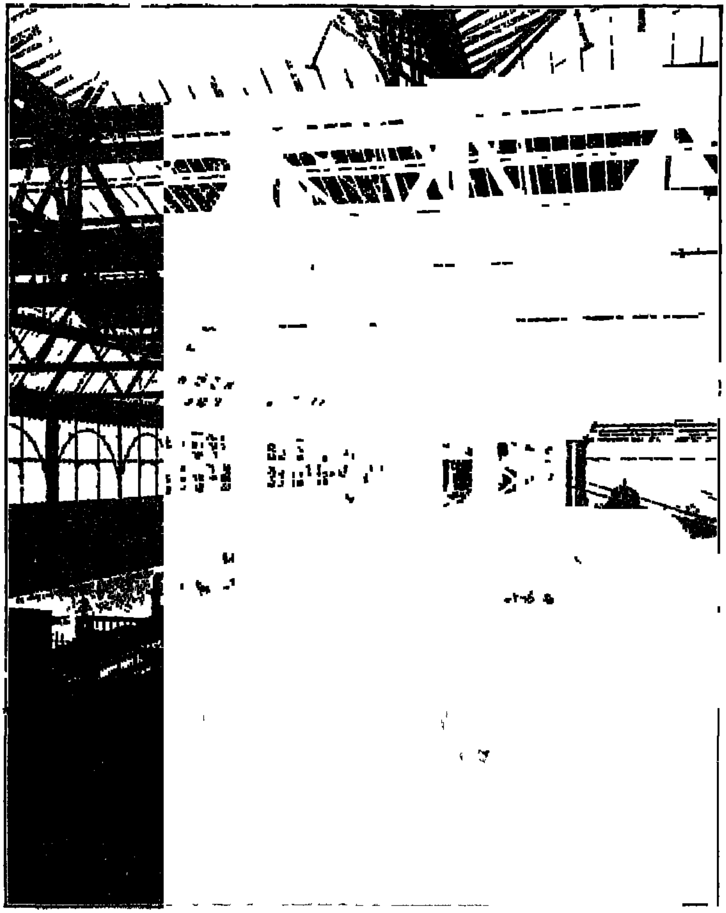
FOUR CYLINDER EXPRESS PASSENGER LOCOMOTIVE, NO 720

it was only two and a quarter miles in length and the outlay nearly two millions, the station being no other than Waterloo, so named from its main entrance in the Waterloo



The new South Station at Waterloo

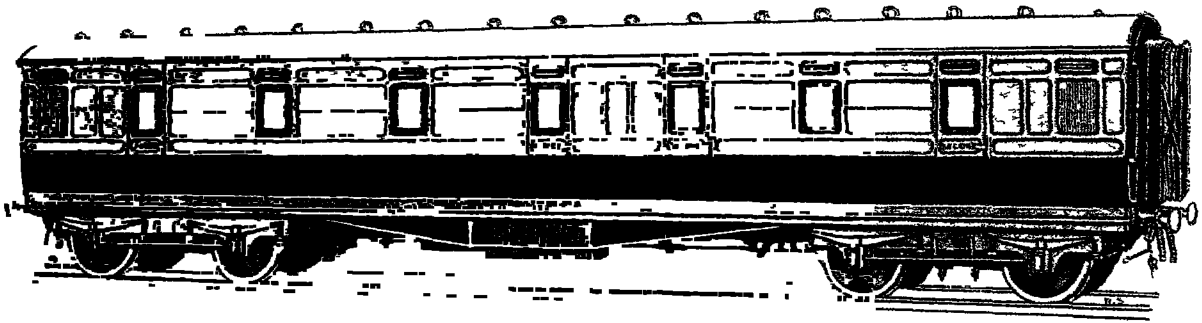
Road The well-known station was not intended to be a terminus, for the line was going farther east along the present route of the South Eastern & Chatham, and much

of the property had been secured, such insignificant items as Barclay & Perkins's brewery and Southwark Bridge being about to be taken over by the company, when the financial crisis made them pull up where they have remained

Waterloo Station now covers twenty-two acres Within it are nineteen roads, that is to say that when full it holds nineteen trains abreast, and the bridge over the Westminster Bridge Road by which it is approached carries eleven roads Over 2500 trains, engines, etc , are dealt with every day, and as many as 12,000 passengers are despatched from it during the busiest half-hour of each working day of the week, for the South Western suburban traffic extends far beyond the range of competing trams

Trains no longer go from London to Salisbury by way of Eastleigh, but direct from Basingstoke, and the main line is fairly straight all the way to Exeter North of it the spurs are to Windsor, Wokingham, and Bulford, south of it the branches lead down, with many intercrossings, to Portsmouth, Southampton, Bournemouth, and Dorchester Beyond Salisbury the southerly branches serve the coast again between Lyme Regis and Exmouth, and from Exeter goes the great curve round the beautiful country of Dartmoor to Plymouth, throwing off the picturesque roads to Barnstaple, Ilfracombe, Torrington, Bude, and Padstow Altogether just over 1000 miles of track, every mile carrying on the average 66,000 passengers a year

The great feature of the system is the way in which the branches loop up with other branches, or end in communication with other systems so as to provide alternative routes and through routes for passengers and merchandise There are less than a couple of dozen loose ends that do not form a junction with some other line, and of these more than half have their terminus on the coast, three of them, Hampton Court, Shepperton, and Windsor, end on the banks of the Thames, and two, Bisley and Bulford, are for military purposes.



THE LONDON & SOUTH WESTERN RAILWAY

COMPOSITE CORRIDOR CARRIAGE No 859

Extreme length, 54′ 0″	Extreme height from rail, 12′ 0″	Two lavatory compartments	Electric lighting
,, width, 8′ 6¾″	First class compartments, 4	Side corridor, with sliding doors	Steam heated
	Second class ,, 3	Vacuum brake	

Carried on pressed steel bogies, having a wheel base of 8′ 0″, and 39′ apart, centre to centre

The South Western is our most important military line It skirts the Channel, and has more military stations on it than any other It connects the three great naval stations, Portsmouth, Portland, and Plymouth, with the two great camps, and serves as many garrison towns as it does cathedral cities The road it jointly owns with the Brighton into Portsmouth is the only one in the country that passes through a rampart. And, owing to the concentration of the troopships at Southampton, it carries every British soldier that goes or returns on foreign service.

On the Channel the seaside towns it serves are Southsea and those of the Isle of Wight, Lee, Lymington, and Bournemouth, Poole, Swanage, and Weymouth, Lyme Regis, Seaton, and Sidmouth, Budleigh Salterton and Exmouth North Cornwall it claims for its own From Bude, the nearest Atlantic port to London, it runs the coach rides northward to Clovelly and southwards to Boscastle that excel all others. From Clovelly downwards is the rockiest, healthiest coast in England Along it is the real blue water, for the nearest over-the-way to the west is America Beautiful in every mood, splendid in the sunshine, terrible in the storm, let those who would know what an Atlantic sea is like venture out in a gale on to the cliffs at Morwenstow or Bude, or that pirate's wild harbour, Boscastle, or even windier Tintagel, and they will learn what they cannot learn on the coasts of the Channel and the North Sea

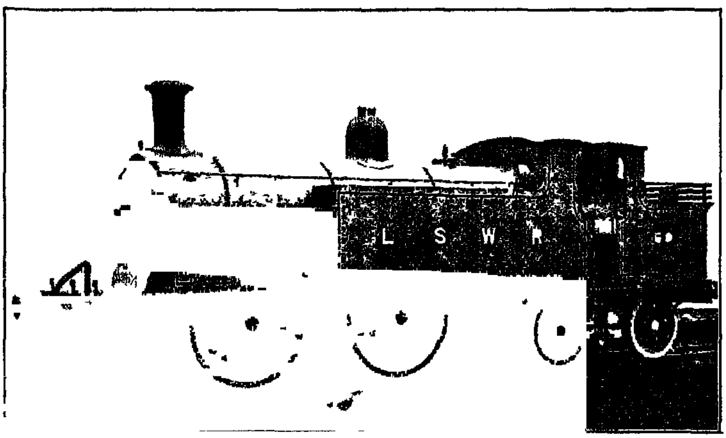
The history of the line in the west is that of a sixty years' war with the Great Western As the champion of the standard gauge in the south, the broad-gauge people naturally endeavoured to stop its advance, and that all the more strongly from its being an invader. But battles over private Bills have lost so much of the little interest they had for those not engaged in them that we need not dwell on them here

What the South Western intended to do was clearly

shown in 1846, when it took shares in the Sutton harbour at Plymouth, which was not reached until forty-two years afterwards, as also in 1845 when it bought the Bodmin & Wadebridge This little, single, narrow-gauge line was opened in 1834 at a cost of £35,000 for the purpose of carrying sand from the Camel River, which the farmers of Bodmin were then using in large quantities as a top-dressing for their pastures It was worked by two engines, the Camel and the Elephant, made by Tregellas Price of Neath On it ran a passenger train, up one day and down the next, up being from Wadebridge on Monday, Wednesday, and Friday It was laid as railroads were laid then, with light rails on tiny chairs fastened down to granite blocks by a couple of tenpenny nails, and was perhaps more lightly built than usual as it was the only sand line ever made, and the sands of its time began to run out from its commencement Eleven years after it was opened, being then in a bad way, the Cornwall Railway, that is the Great Western under another name, offered to buy it, provided the Cornwall Railway Act was obtained, and the Cornwall & Devon Central, the competing company, did likewise whether they got their Act or not The Wadebridge people accepted the definite offer—£33,096, 9s 8d —and the Cornwall & Devon Central, which never had a line but were financed from Nine Elms, passed on the bargain to the South Western, who thus obtained an outpost in the west, two hundred miles away, which it took fifty years to reach, and now works with a steam rail-motor car

The most noteworthy of the links towards it was the Salisbury & Yeovil, which when the first sod was cut in April 1856 had a bank balance of £4, 2s 4d With many a struggle, frequently with no idea where the next £500 was coming from, it paid for the work of almost all kinds with shares at a greater and greater discount, until the cost, half a million, was somehow met, and then it was

opened, worked by the South Western for half its gross receipts When the Yeovil & Exeter was opened this 50 per cent became 42½ for twenty-one years, plus a quarter of the traffic receipts to the South Western stations, an onerous undertaking resulting in the line being worked at such a loss to the South Western, and such a profit to the Salisbury & Yeovil, that in 1878 the South Western bought the property And the price was £260 for each £100, so that its shareholders, whose early prospects were so gloomy, secured 13 per cent in the few cases in which



Tank Engine No 59—a type used for the heavy suburban traffic

they had bought at par, and higher rates in proportion to the lower prices at which the shares had been distributed to them

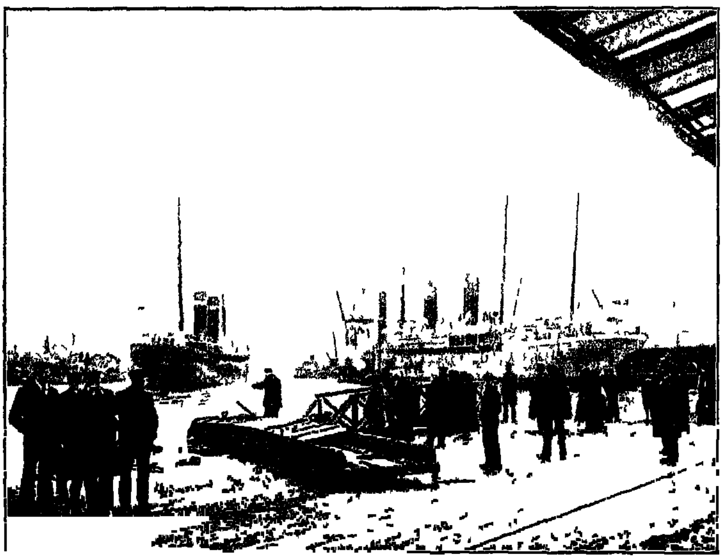
The South Western owes a good deal to "running powers" It crosses the Great Western at Exeter on nearly a mile and a half of the competing line It gets into Plymouth on over two and a half miles of the Great Western, into Weymouth on nearly seven miles of the Great Western, into Reading on nearly seven miles of the South Eastern & Chatham, and into Portsmouth,

by the direct route, on nearly four miles of the Brighton (from Havant to Port Creek) These are all triumphs of its diplomacy, but perhaps the smartest thing it did was the purchase of the line to Midhurst, by which it stopped the advance of the Brighton to Southampton

Southampton, the pleasantest of our larger ports, is the real heart of the South Western and the main cause of its prosperity, for it means goods, and no railway company can thrive without goods When the London & Southampton was launched the dock scheme was undertaken by another company, who began by building what is known as the Outer Dock Before that dock was opened the Royal Mail Steam Packet Company, and the Peninsular & Oriental, had begun business, and made Southampton their headquarters, and in 1847 steamers from Bremen, owned in New York, began to call in, these being the predecessors of the North German Lloyd, a company formed at Bremen in 1856, which has all along made Southampton its English port of call In 1845 the South Western Steam Navigation Company purchased the Channel Island boats, which had up to then been running from Weymouth, and transferred them to Southampton, adding a service to Havre In 1862 the South Western took over this company, thereby increasing its interest in the docks, and the successors of these old paddle boats continue both services and are among the best that cross the Channel It was the trade with the Channel Islands, still worked from the Outer Dock, that led to the subsequent developments, though the business done in the carriage of passengers and merchandise brought by the ocean-going steamers became increasingly important.

For instance, in 1853 there started the Union Steam Collier Company, with a view to supplying coal to the vessels frequenting the port, but during the Crimean War the P & O fleet were taken up as transports, and the Union boats were put on to trade with the Levant

in their place until they were in turn secured for transport purposes When the war was over employment had to be found for these boats, which, as the Union Steamship Company, endeavoured to open a trade with South America, and in 1857 left the South American trade for the South African, owing to the company obtaining the mail contract to the Cape The same year the Bremen steamers having found it pay them to call at Southampton, the opposition line from Hamburg, the Hamburg-American, followed their example, greatly to the advantage of the



Departure of an American Liner from Southampton Docks

dock company whose only difficulty was how to find capital for improving the accommodation In 1875, as nothing was done, the P & O left for the Thames, causing a drop of 50,000 in the port's tonnage, which a sudden spurt of trade more than made good in the next year's return Prosperity continuing, and matters going on

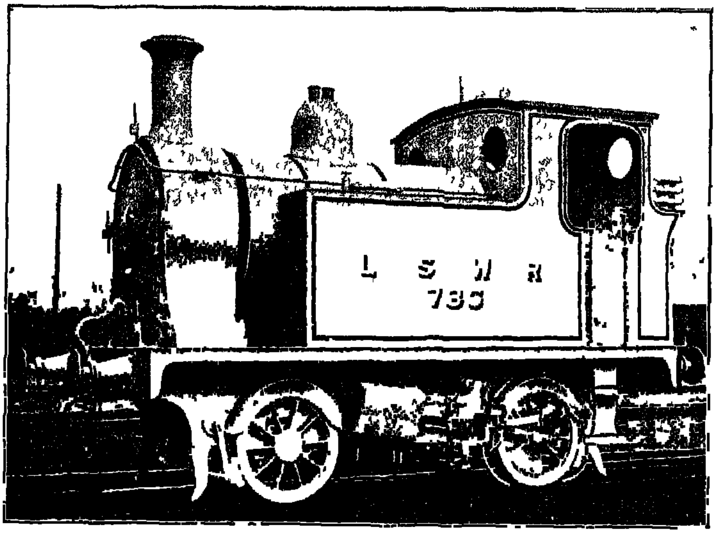
in the old way, negotiations were begun in 1883 for the town authorities to take over the docks and make the inevitable enlargement, and as these failed the dock people applied to the railway company for help

The man was ready for the hour In 1885 Sir Charles Scotter, then Goods Manager of the Manchester, Sheffield & Lincolnshire, had been appointed General Manager of the London & South Western He had begun his career with the M. S & L at Hull, and he had risen to have the management of Grimsby, and no man in the country knew more about docks, and what could be done with them when they were owned by a railway company Little wonder, then, that in 1886 the South Western subscribed a quarter of a million to the dock company's capital account for the extensions to be put in hand, and that six years afterwards the railway company should become the sole owners of the property with a view to the greater developments that are still going on

Southampton is fortunate in its position in the middle of the south coast, under eighty miles from the capital, and about half as much again from the Welsh coalfield and the manufacturing towns of the Midlands Across the mouth of the estuary lies the Isle of Wight, acting as a huge breakwater, favouring it, like a few other places in the world, with a double tide As the tide runs up Channel it sends off a branch at the Needles into the Solent, and proceeding along the south of the island it sends another branch into Spithead about a couple of hours later, the main tide, in fact, which reaches Southampton Water from the east before the one from the west has had time to get out Thus there are four tides a day, and as there is water enough for all ships at all times, and the anchorage is excellent and well sheltered, the port requires not basins but graving-docks, and quays and jetties along its river fronts.

The business largely lies along the outer wall, and the

quayage is great, the docks being traversed by over thirty miles of railway, and the outfit of steam, hydraulic, and electric appliances for hauling and lifting is unusually large, for three-fourths of the light imports are sent to London, being perishable articles calling for instant despatch. The heavier goods are more widely distributed, and for



A smart and useful Locomotive, No 736

those that have to stay for a while there are huge warehouses, bonded and free, for all kinds of merchandise, and grain stores with elevators and travellers that deal with 200 tons an hour

The oldest trade of the port is that in wine, and the amount is now enormous, the newest trade is that in chilled provisions, and the cold storage accommodation of 2,000,000 cubic feet is the largest in the country This cold storage business is a most interesting feature, for the meat is not loaded into covered wagons, but direct into road vans with their shafts taken off, and their wheels

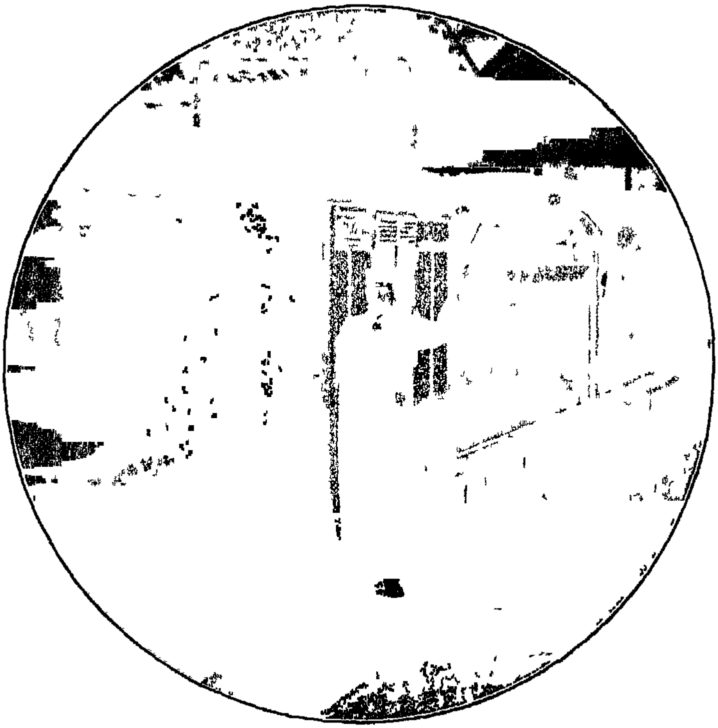
lashed to iron rails on double carriage trucks A train of these carts, each taking thirty-four quarters of beef, is loaded alongside the stores and run straight up to Nine Elms where the horses are awaiting them, and the load, after being handled only once, is delivered at Smithfield within four hours of leaving the cold room at Southampton

What with the many liners now using the port, and the troopers and smaller fry, there is always plenty of shipping about, and many steamers mean much coal, and Southampton handles coal in a way of its own The only storage is in lighters, so that it is ready to be towed to the ships as soon as ordered Along the river fronts of the coal barge docks runs a narrow jetty, where the cranes lift the coal out of the colliers a couple of tons at a time and swing it across into the lighters waiting on the other side in such numbers that 14,000 tons of coal may be afloat at once, there being lighterage capacity for no less than 20,000

Another of the Southampton sights is the Prince of Wales graving-dock, 750 ft long and 112 ft wide, a vast cavity in which the men, apparently dwarfed to half their size, work in the dry owing to the constructor having thoughtfully made it turtle-backed, so as to drain the water off at the sides instead of in the middle Big as it is it can be filled in an hour and a half and emptied in two hours and a half by means of centrifugal pumps a yard in diameter Farther on is the Trafalgar graving-dock, which is larger, it being 875 ft in length, and each of its gates weighs 250 tons! And even this is to be enlarged In short, the dock business is being worked for all it is worth, and it will not be the fault of the South Western if its growth is in any way checked.

The Midhurst branch goes off at Petersfield on the Portsmouth Direct, which has an interesting history It was made by Brassey for an independent company, a line of heavy gradients with its summit at Haslemere, 460 ft above the Waterloo level, to join up with the South

Western at Godalming and with the Brighton at Havant, and was ready for opening in January 1858, but the owners had made no preparations for working it, and had provided no rolling stock, hoping that one of these companies would take it over The Brighton people would not undertake the task, as it was a competing route to Portsmouth, to



A Guard of the South Western

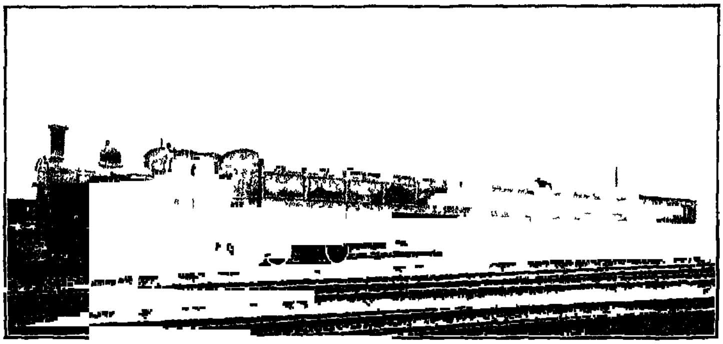
which they had been running for eleven years, and the South Western declined, as it would interfere with their agreement with the Brighton Then the owners obtained parliamentary sanction for a junction with the South Eastern at Shalford, hoping that that company would come to the rescue, but received the same reply, that prior

arrangements with the Brighton precluded any such working of an opposition line One way out of the difficulty seemed to be to continue the Portsmouth Direct to Portsmouth, which led to the proposal of another Portsmouth terminus at Landport This did not suit either the Brighton or the South Western, and at last the South Western were persuaded to take a perpetual lease of the line at a rental of £18,000 a year and risk a war

The Brighton at once accepted the challenge It was on the 1st of January 1859 that the first South Western train attempted to run on to the Brighton metals at Havant It was to reach there at 10 a m , but expecting trouble it came at 7 a m , a train specially manned with 100 platelayers under the command of the secretary of the company, who on his arrival found the rails taken up at the junction and an engine with its wheels chained and padlocked down to the rails at the crossing A fight began between the rival roughs , the Brighton men were driven back and held at bay, while the South Westerners made good the track, filed through the chains, moved the Brighton engine off and brought their own train on to the metals But while they were busy in front their opponents were as busy behind, and when the South Westerners advanced they found that rails had been removed farther on, so that progress was impossible And so the Waterloo men returned to fight the battle with legal weapons that proved so efficient that on the 24th of the month they triumphantly rode into Portsmouth on the metals of the discomfited Brightonians, who forthwith began a war of rates and fares which did nothing beyond causing them a loss of £80,000

One of the best moves made by the South Western was the leasing of the Somerset & Dorset in conjunction with the Midland. By this Bournemouth obtained the direct route to the north, by which it has profited so much, and the joint companies not only obtained access through Glastonbury to Wells, Burnham, and Bridgwater, but a

short communication between each other's territory The Somerset & Dorset affords a remarkable instance of development since it ceased to be local and became linked up into a main road The broad-gauge Somerset Central, from Highbridge on the Bristol & Exeter to Glastonbury, obtained its Act in 1852, four years afterwards the narrow-gauge Dorset Central was incorporated to run from Wimborne to Blandford, obtaining powers in 1857 to continue north-westwards, and, crossing the Salisbury & Yeovil at Templecombe, meet an extension of the Somerset Central through



The Vestibule Train working in the Plymouth District

West Pennard and Pylle The companies then amalgamated, and, as the Somerset & Dorset, built a branch from Evercreech to the Midland at Bath, which was opened in 1874, and next year the Midland and the South Western jointly took over the system on a 999 years' lease and made it narrow-gauge throughout From the first the traffic began to improve, and now the line, which is one of the few on which the whole of the trade is dealt with by rolling stock of its own, requires about ninety engines to work it

In 1865 the South Western took over a group of broad-gauge lines giving access to Barnstaple These originated in the Taw Vale Railway, which after a troubled infancy was built by Brassey during the three years from 1851 as

the North Devon Railway and Dock Company It ran from Crediton to Umberleigh Brassey leased this line, opened in 1854, as he also did the extension to Bideford from Framlingham Pill, opened in 1855; but in 1863 the South Western secured the North Devon on a lease for a thousand years, and two years after absorbed both it and its extension

The most difficult working on the South Western is that on the Ilfracombe branch, which was made by an independent company after many adventures It cost only £130,000, and has more heavy gradients and difficult curves than any other stretch of fifteen miles It begins with a rise, and falls a little only to rise again, and ends in a two-mile down-grade of 1 in 36 that lands the passenger on a hill 100 ft above the sea The Great Western Company run on it by arrangement from the junction at Barnstaple, and their trains have to go even more slowly from Morthoe to Ilfracombe than on the harbour branch of the Weymouth & Portland, which is generally reputed to be the slowest bit of work in Britain Another laborious journey is that round Dartmoor, where greater heights are reached, the summit level of the system, 950 ft, being on that fine section between Okehampton and Tavistock, just after passing over the Meldon viaduct before reaching Bridestowe This is on the way to the South Western's other dockyard, for it serves two, Devonport and Portsmouth, just as it serves the two great military camps, Aldershot and Salisbury Plain, and the two ranges, Bisley and Okehampton

The Meldon viaduct and the Honiton tunnel (1353 yards, the longest on the line) are the two most conspicuous engineering works, if we except the embankments, which do not appeal so much to the traveller In the making of the line gradients were not worried about overmuch, and were generally taken as they came Hence the South Western is more undulating than it might have been had the cost of working it been borne more in mind. Some of the

inclines are very long, as shown by the distances between the gradient-boards

These boards, it may be as well to say, which are on the down-side on the South Western and many lines, and on the up-side on others, are required by the Board of Trade to be placed wherever the gradient changes, the arms pointing upwards or downwards according to the slope of the road The posts for the miles and their halves and quarters are also placed on the line to satisfy the Board of Trade, but owing to amalgamations and short-cuts they have to be used with some discretion as indicating the old road instead of the new, and it is advisable to check the length of the journey they denote by adding up the distances between junction and junction The South Eastern, for instance, goes by four ways to Ashford, and they cannot be all of the same length, as they appear to be from the posts beyond that station Other examples will at once occur to the reader, such as the Great Western roads to Weymouth and to Exeter, and the South Western roads to Guildford, Aldershot, Winchester, Kingston, and several other places

The South Western is a great line, and has extended far beyond the five towns whose arms figure in its coat of arms, London, Salisbury, Winchester (with the lions and castles), Southampton (with the roses), and Portsmouth It has always been faster than the others working south of the Thames, indeed in 1847 it was running the fastest train in the world, the Southampton express, which did the 78 miles in 105 minutes including the stop at Basingstoke. Its first locomotive superintendent was John V Gooch, the brother of the Great Western Gooch, who was just as eager for speed , and this Southampton train was worked by one of his first engines which had 7 ft wheels, the largest then in use on the standard gauge

When he left the South Western for the Eastern Counties he was succeeded by James Beattie, who did away with the use of coke as a fuel and in 1855 built the Canute,

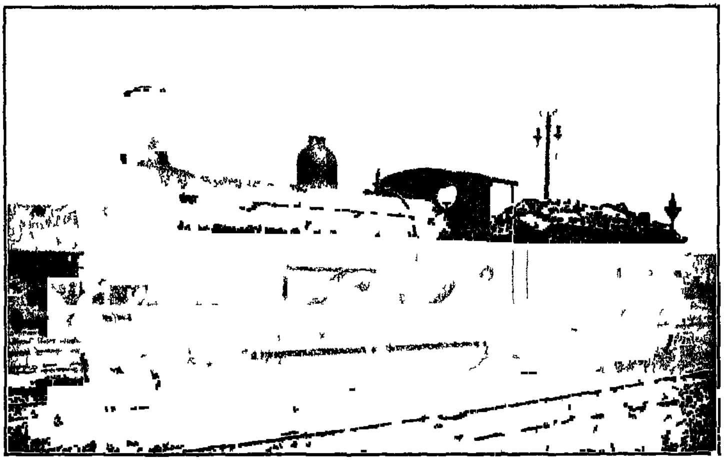
the first engine to burn coal In his "smoke-consuming locomotive" he put a combustion chamber, and an enlarged firebox divided transversely by an inclined water-bridge, and containing his great improvement the fire-brick arch He also perforated the fire-door, and used ashpan dampers and an auxiliary steam-jet to keep the fire going while the engine was at rest The Canute's driving wheels were 6 ft 6 in, she had outside cylinders 15 in in diameter with a 21-in stroke, her firebox was 4 ft 11 in long, 3 ft 6 in wide, 5 ft 1 in deep at the back and 4 ft 1 in at the front, the area being 107 sq ft, her combustion chamber, 4 ft 2 in long and 3 ft 6 in across, had a flat roof, the area being 37 sq ft, she had 373 tubes $1\frac{1}{4}$ in in diameter and 6 ft long, with an area of 625 sq ft, her fire-grate was 16 sq ft in area, and the bricks for consuming the smoke had a surface of 80 sq ft She had also a feed-water heating apparatus, and was altogether a remarkable engine Beattie began, it is worth noting, by using two fires, one of coal, the other of coke for consuming the coal smoke, but he soon found that he could get on just as well with coal alone The 85 in coupleds—2-4-0, the leading wheels being 48 in—which worked the South Western expresses for so many years were also designed by Beattie

Beattie, who was carriage superintendent before he took charge of the engine department, was the first to make railway wheels of wood and iron Wooden wheels had been tried before, as in the case of the Kilmarnock engine, but the combination was a novelty and it was a success, one set of his wheels running 75,000 miles before being returned to the lathe This was about six years before the invention of Mansell's wheel, now generally used for passenger carriages

The Mansell wheel is built up of sixteen segments $3\frac{1}{2}$ in thick, fastened to the steel boss by bolts passing through the steel disk The steel tyre is shrunk on to the

wood body, which has the grain arranged radially, and the axle is driven into the steel boss at a pressure of sixty tons, giving such a fit that no key is needed. The wheel is free from noise, fans up no dust, and its tyre does not fall off when it fractures, and it is easily balanced.

That the wheels of the engine are balanced everybody knows, but it is not everybody who is aware that the wheels of the carriage are treated in a similar way, or that an unbalanced wheel has a tendency to revolve about its



Goods Engine No. 691 (with conical front)

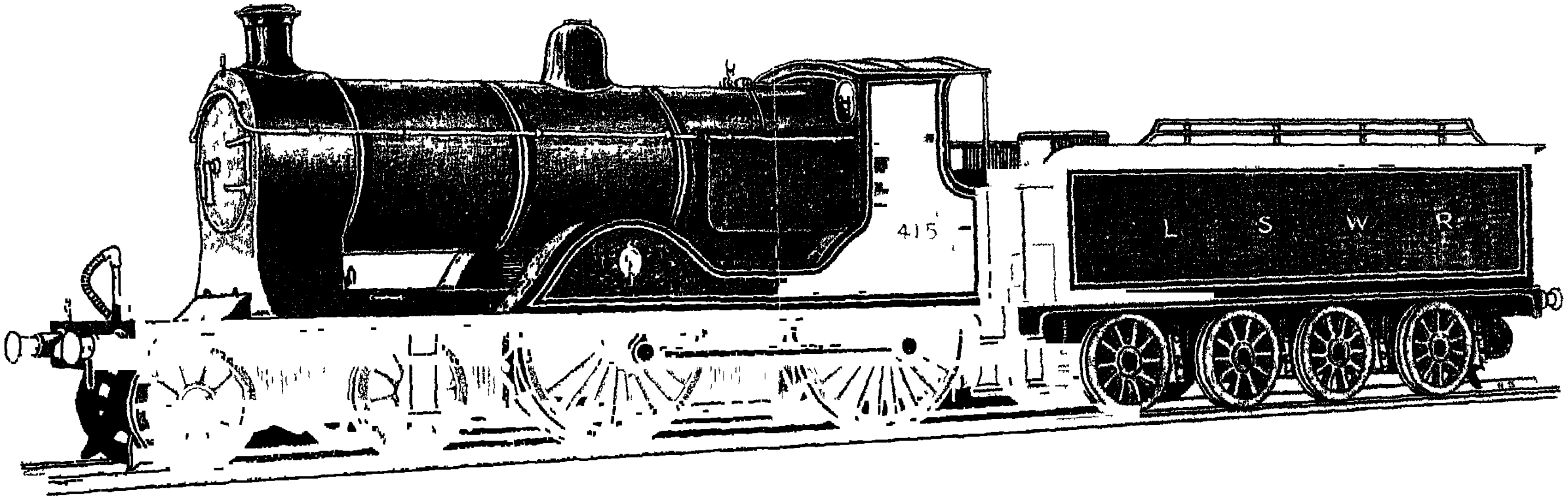
centre of gravity instead of the centre of its axle, and soon develops flat sections on its tread. The balancing of a wheel is not difficult. The pair of wheels on their axle are placed on bearings mounted on leaf springs, and spun round by a pulley for three minutes beneath two markers of chalk fixed so as to just touch the top of the tyres, and by the appearance of the chalk line they take the character of their running can be seen. If they do not run true a small plate of iron of the necessary weight is screwed on to their inside face, and this is altered after trial until the wheel is as

it should be. Everything is done to build the wheel so that it requires no balancing, even the segments are weighed separately before being fitted together, but as a rule about 10 per cent. have to carry for life a balance weight of a pound or so.

Another invention of Beattie's was his buffing apparatus, which had elliptical springs of steel separated by layers of flannel placed between a series of blocks working in the under-frame of the carriage, and thereby protected from the weather. Several more small ingenuities were his, and he certainly ought not to be allowed to drop out of remembrance as he seems to have very nearly done. His passenger engines had their steam domes on the top of the fireboxes. The eight designed by his son and successor, W. G. Beattie, had Ramsbottom safety valves on the firebox and the steam dome half-way along the boiler barrel.

When Mr. William Adams became chief mechanical engineer he designed over a dozen classes of engines for the line, the best known being the powerful 85 in. coupled, with the 4-wheeled leading bogie (4–4–0), the frames of which project far in front of the firebox. In these he put a small steam valve in front of the main one to reduce the frictional resistance, and fitted his vortex blast-pipe to reduce the consumption of coal. In this the steam is discharged as a hollow cylindrical jet through a circular orifice enclosing an air-pipe which widens out into a large bell-mouth in front of the lower tubes, these being more difficult to clear by the blast owing to the vacuum having a stronger effect in the upper half, as shown by the upper tubes wearing away faster than the lower ones.

The steam blast, insignificant as it may seem, is the secret of the locomotive, and it was discovered by Richard Trevithick in building his first railway engine. Not caring to part with his waste steam until it had done a little more work, he used it for heating the feed-pipe, and led it into the chimney, perhaps at Rumford's suggestion, to increase the



THE LONDON & SOUTH WESTERN RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 415

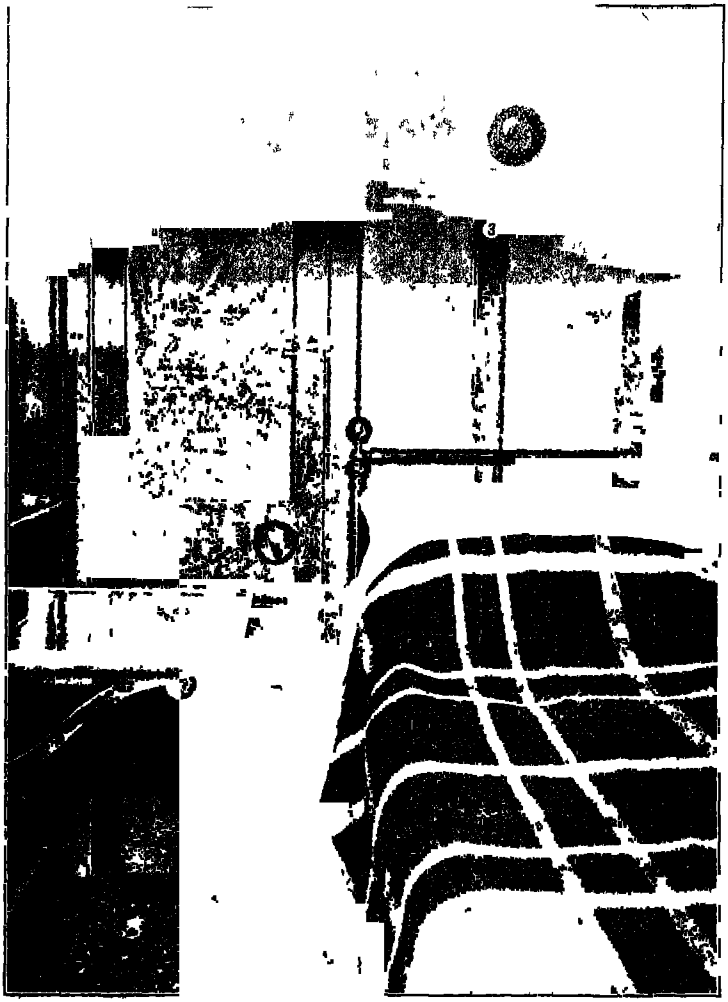
DESIGNED BY MR D DRUMMOND M INST C E

BOILER	Length	10′ 6″
	Diameter	4′ 9½″
CYLINDERS	Diameter	19″
	Stroke	26″
TUBES No		247
FIRE BOX	Length	7′ 4″
	Width	4′ 0½″
HEATING SURFACE	Flue tubes	1222 sq ft
	Water tubes	165 ,,
	Fire box	163 ,,
	Total	1550 sq ft
DIAMETER OF WHEELS	Bogie	3′ 7″
	Coupled	6′ 7″
GRATE AREA		24 sq ft
WORKING PRESSURE		175 lb per sq inch

WEIGHT IN WORKING ORDER		Tons	Cwt
	Engine	54	0
	Tender	44	16
	Total	Tons 98	16

WATER CAPACITY	4000 galls
COAL CAPACITY	4 tons

draught by causing a vacuum in the smoke-box For its



A comfortable Sleeping Berth on the Plymouth Mail

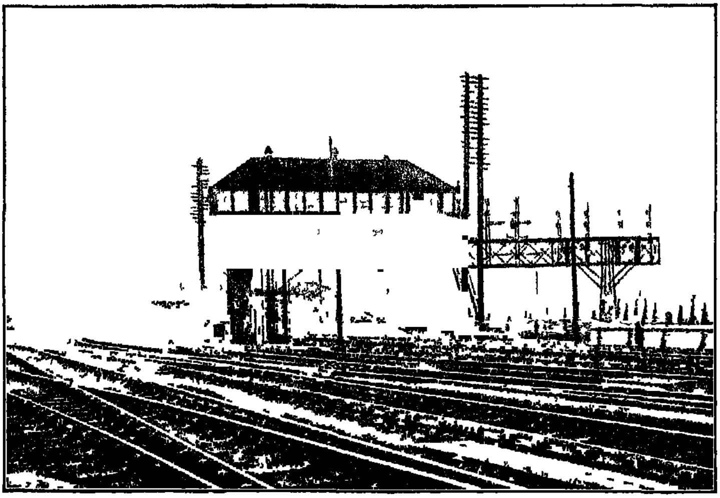
effect to be satisfactory the blast must issue vertically from the very centre of the vertical chimney, the very slightest

deviation to one side seriously checking the engine's working The smaller the outlet the sharper the blast, but too small an outlet causes back pressure in the cylinders, and thus the pipe must be large enough for the engine to work well The size depends on the amount of steam the boiler makes and the engine uses, but is rarely less than 4½ in, and generally an eighth or two more, for even the difference of an eighth will make a difference in the coal bill, hence No 335 of this line, which is a large engine, has a variable blast ranging from 4¼ to 5½ in

The last big 85 in of the Adams design was No 686, put on the rail in 1895, for in August of that year Mr Dugald Drummond became chief at Nine Elms No 686, the last of the Adams engines, was the last with a number plate of raised figures on a red ground, No 242, the first of the Drummond engines, was the first with a beaded rim round the chimney, like all that followed The most noteworthy of these was No 720, completed in 1897, the first of five others (369–373), a 4-cylinder engine with the front pair of wheels driven by the inside cylinders and the rear pair driven by the outsiders, the wheels being 79 in and the heating surface, at first, 1664 As enough steam could not be got to work this double-single satisfactorily, a larger boiler was given her in 1905, the heating surface being increased to 1750 That year came another new idea, a class of thirty (Nos 702–719, 721–732) being given 61 water-tubes 2½ in in diameter, sloped across the firebox, and ending in the rectangular casing at the sides which distinguishes all such engines The cylinders of this first group are 18½, stroke 26, driving wheels 79 in., heating surface 1500, grate area 24, and pressure 175. An improvement on these in appearance, owing to the wider space over the footplate and the absence of the little raised splasher covering the throw of the coupling-rod, was the class begun with No 300, which, with the tender, weighed in working order 93 tons 14 cwt One of these engines,

No 336, has brought the American express from Templecombe West to Waterloo, 112½ miles, in 104½ minutes

In 1905 another class of 4-cylinders (330–334) was introduced, with six wheels coupled, the drivers being 6 ft and the bogies 3 ft 7 in In these engines, which complete with tender weigh 117 tons 17 cwt, the cylinders are 16 in with a 24-in stroke, and the heating surface, including that of the 112 water-tubes in the firebox, 2727 sq ft, the grate area being 31½ sq ft One of these,



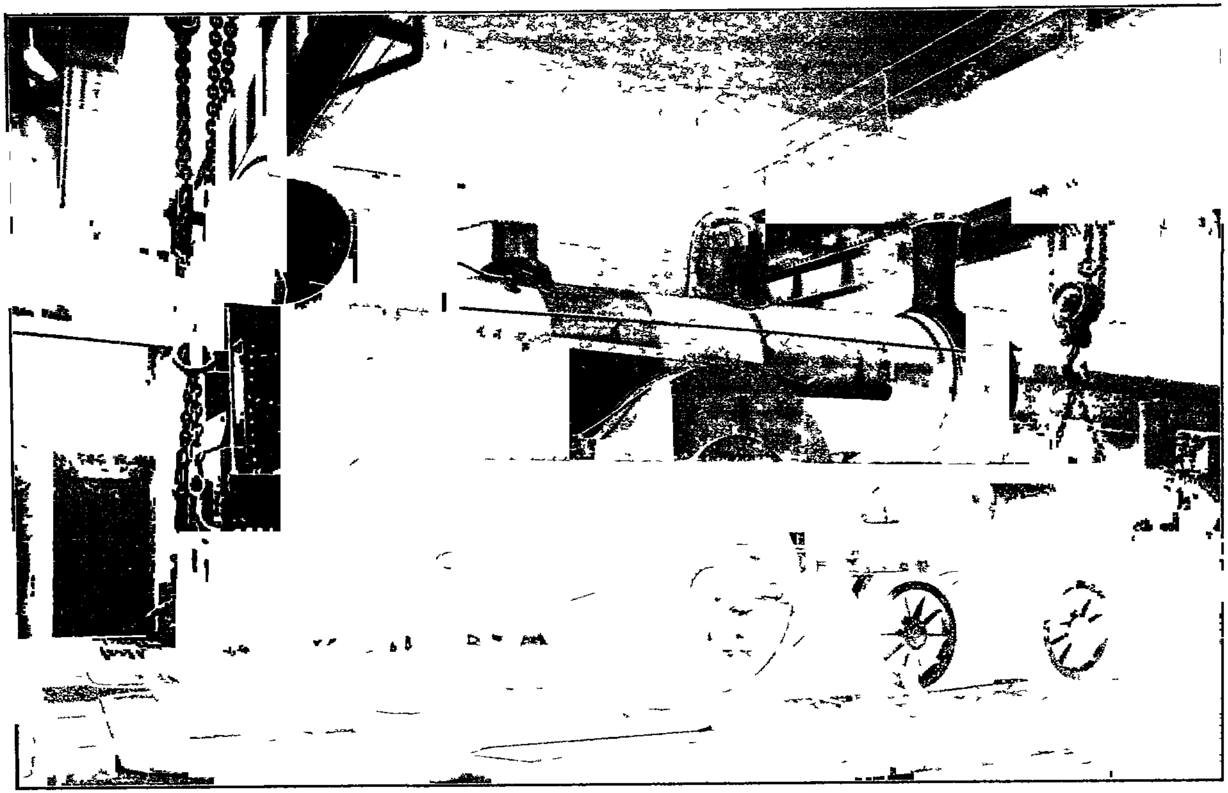
The approach to Clapham Junction (from the London end)

worked up to 1060 horse-power, attained a maximum speed on the Exeter to Salisbury road of 75 miles an hour In 1907 came the bigger No 335, the first of the South Western engines to be fitted with a pick-up water attachment, though no water-troughs had been laid down This was of the same type, but with cylinders 16½ and stroke 26, and later on in the year came five more of these 6-coupled 4 cylinders, with a cylinder diameter of 15 and a stroke of 26, and 1920 sq ft of heating surface

The reader is doubtless aware that in the ordinary locomotive boiler the water surrounds the tubes, while in the firebox-tubes the water is in the tubes, thus this 1920 sq ft of heating surface is made up of 140 for the firebox, 200 for the 84 water-tubes in the firebox, and 1580 for the 247 flue-tubes in the boiler All these engines carry the Drummond feed-water heating apparatus, consisting of tubes in the well from which the condensed steam passes out into the air through the baffle-plates at the back of the tender, the water entering the boiler at a temperature only twelve degrees below boiling point

Like the Lancashire & Yorkshire, the South Western uses dwarf locomotives for its rail motor-coaches When engine and coach are in one, any breakdown of engine or coach means keeping the whole affair in the shops for repair, but by having them separate either can be in the shops while the other is at work—a system which has evident advantages These little engines, with wheels a yard across, have 9-in cylinders with a 14-in stroke They work at a pressure of 150, and have a heating surface of 347, of which 119 is given by the water-tubes

All these engines were built at Nine Elms For half a century or more these works had been doomed, but something always happened to delay the inevitable So definite was the notice to quit that the men used to be warned on engagement against taking houses or lodgings for long periods, and yet things lingered on in the old style until the shift to Eastleigh became a standing joke Even the removal thither of the carriage works failed to convince people that Nine Elms would one day cease from engine-building Eastleigh, like Crewe, is a railway town pure and simple, and it started with a smaller nucleus, for on its site were only a few straggling cottages and a lane or two between the farm-lands where miles of rails run into and about as fine a group of workshops as can be found At present there is space enough and room to



I—L 128

IN THE ERECTING SHOP AT NINE ELMS   PLACING AN ENGINE ON ITS WHEELS

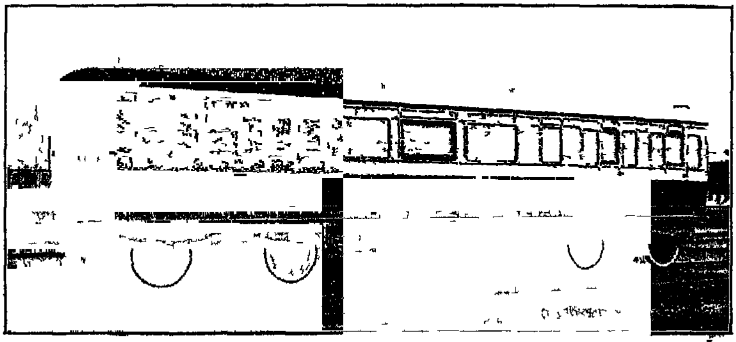
spare, but whether that will be the case for long remains to be seen

From the removal of the carriage-building department to Eastleigh dates a great improvement in the line's rolling stock The railway carriage has developed considerably since the days of the four old Bodmin & Wadebridge coaches, which are still kept as curiosities—the open thirds, the second-class with glass only in one panel, the gay blue and white composite, the buffers like boxing-gloves made of leather and stuffed with hair Really the contrast is great between these survivals and the comfortable invalid or family carriage that can be sent through on to any line, the long sleeping saloons, the restaurant cars ready for any meal to which a name can be given, or the carriages that form the bulk of the ordinary trains In the old days it was the fashion to make up a train of as many different varieties in colour and shape as possible, nowadays it is the train and not the carriage that is the unit, and the South Western expresses to Bournemouth, Cornwall, and elsewhere are equal in good looks to those of any of the lines to the north

The South Western owns about 750 engines and nearly 19,000 carriages and wagons, and it runs nearly 20,000,000 miles a year, three-fourths of this being passenger traffic, which yields three and a third out of its five and a half millions of revenue. This is a much smaller proportion than that of the Brighton or the South Eastern, the greater amount for goods, and so on, being due, of course, to Southampton. In fact the South Western makes more out of its docks and shipping than any other railway company, more even than the Lancashire & Yorkshire, nearly £100,000 a year more than the Cardiff, £120,000 more than the Barry, and £80,000 more than the North Eastern and Great Central combined

It has a fleet of eighteen vessels of its own, and has a half share in the Ryde boats from Portsmouth and Stokes

Bay, the other half being held by the Brighton company Two of its small boats do the service from Lymington to Yarmouth at the west end of the Isle of Wight, where, at each port, there are special slipways to provide for motor-cars running on and off the boat without being slung, another acts as a tender at Plymouth, the other fifteen plying between Southampton and the Channel Islands, and the northern ports of France from Havre to Roscoff The amount of fruit and vegetables these Channel boats bring into the country can only be appreciated by those who have waited in them at Guernsey while

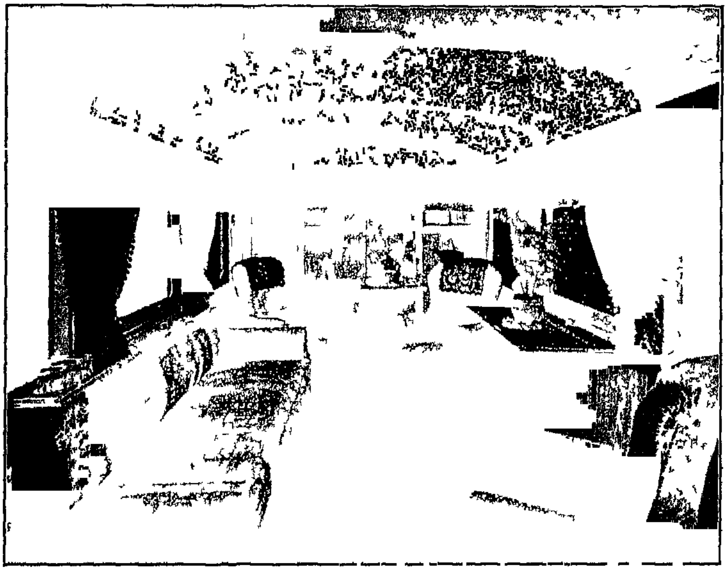


The "Family Coach" or Invalid Carriage

cartload upon cartload comes pouring into them, or seen the whole cargo unloaded and dealt with at Southampton It is not only Jersey potatoes that arrive in tons, nor cauliflowers, nor tomatoes, but almost everything, even strawberries, that are shipped in such quantities from Honfleur and St Malo, that they not only fill the holds but occasionally half the deck Only one thing seems special to any particular port, and that is those best of onions from Brittany, which come from Roscoff in baskets and are strung on to straw ropes in their last stage of transit This is a curious little trade, for the men come with them, and after selling them from door to door in

the chief cities, keeping a record of the address of every purchaser, meet at Southampton to return together by the same boat

It was the South Western that gave the first trial to automatic signalling, the section of line being between Andover and Grateley on the main road to Salisbury On that 6½ miles the apparatus began to work on the 20th of



Interior of the Family Carriage.

April 1902, the first to attract attention of several systems now developing so fast that the old signal-box with its signalmen is evidently doomed

Who invented signalling is not clear, but it began with the hat and umbrella, and officially with the red necktie That red neckerchief has done much good work in its time both by day and night, for at night it has been stretched over a lamp and given warning of danger to a train that was running into the scene of an accident,

Once, according to Williams, a red pocket-handkerchief was used for train-stopping purposes by an Irishman trespassing on the Great Western, who seeing an express approaching ran a short distance up the side of a cutting and waved it at the end of a stick. The warning was not disregarded, the brakes were applied, and the train came to a halt. A hundred heads were thrust out of the carriage windows, and the guard had scarcely time to ask what was the matter before the Irishman asked to be given a bit of a ride. So polite a request was not to be denied, and the guard as politely answered, "Oh, certainly; jump in here." The Irishman was soon ensconced in the luggage van, but instead of having the ride for his thanks, the guard handed him over to the magisterial authorities, who taught him that railway companies did not run expresses for giving lifts to practical jokers.

Night signals seem to have begun with the tallow candle stuck in his window by a Stockton & Darlington stationmaster when he had a passenger waiting for the train. When the Liverpool & Manchester opened in 1830 the candle had got into a lamp and the necktie had become a flag. Four years afterwards the flag and lamp had mounted a post 5 ft. high; and in the course of the next three years the post had grown to 12 ft., the flag had become a disk, and the lamp had red glass in one of its panels. These disks, which were adopted because the flag always blew to leeward and the wind did not always blow from one direction, were turned parallel to the line for all clear, as a rule, but in some cases they were hinged at the top so that they could be worked like a lid.

Many of the railway companies have a few of their old signals kept as curiosities. At Gloucester the Great Western has quite a collection. In these the cross-bar appears, and it is at right angles to the disk. The main-line down signal has one disk and the bar with return

ends pointing downwards, the up signal having no return ends, the signal at level crossings having ends pointing both up and down On branch lines there were two

Interior of Vestibule Train used in the Plymouth District

disks and two bars, the smaller in each case being at the top, the ups having no return ends, and the downs having the down-pointing ends as on the main line One signal, from Windsor viaduct, is a large disk with a wide rim,

this was known as a tambourine, and it showed as a circle when upright and as a bar when horizontal Another of the sort that continued in use on the Forest of Dean until 1904, is a plain flat bar with a swallow-tail at one end and a point at the other such as is now used by the platelayers, and another is the capstan worked by a lever which was used at facing points It was from these that the present disk signals were developed

In 1841 there was erected at New Cross the first semaphore used on a railway The only originality was in the application, for close by on Telegraph Hill was one of the series of semaphores communicating with Dover. These were the old telegraphs for which the word—*sema* a signal, and *phoros*, bearing—was coined, and they had existed for half a century before Charles Gregory used them for the railway purposes There is one at Portsmouth dockyard still, and they were on every prominent hill between the Admiralty and the coast for the transmission of messages in the style still used by the navy and army In short, the semaphore was the telegraph, and we talk of the electric telegraph to distinguish it from the mechanical one from the motions of whose arm it got the beats of the needle and the dots and dashes of the Morse code

Just as the capstan signal was worked by a lever at the base, so was the semaphore There were no leading wires, and the man had to be at his post, in both senses, when the arm was raised or lowered This, however, did not last long, for on the North British a certain porter was given two signals to look after, and to save himself the trouble of walking from one to the other he brought along a pulley and some wire, and hanging a broken chair on to the lever as a counterweight, he fastened one end of the wire to the lever, passed the other through the pulley, and worked the signal comfortably from his hut It was a simple thing, such as a boy would have thought of, but

it started railway signalling as we know it, and that hut at Meadowbank was the first signal-box

At many junctions the signalman was also pointsman, his duty being to move the sliding guide-rail and fix it into position with an iron pin, but when Sir Charles Fox invented the switch the rods were led into the signal-box, and the man had to look after two sets of levers, those

The new Station at Farnborough

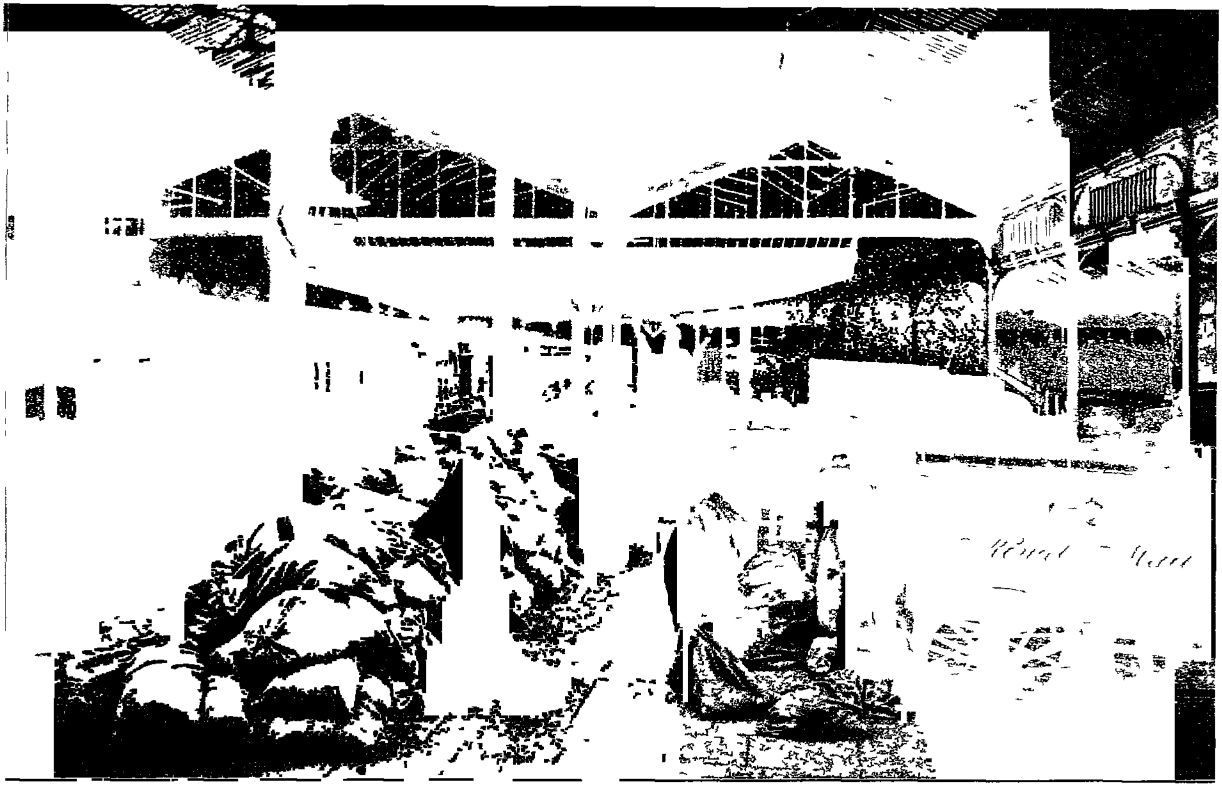
for the signals and those for the points The next step was the interlocking, which came in about 1843, though nothing much was done with it until 1856, when Saxby concentrated and interlocked the points and signals at Bricklayers Arms

For some time the semaphore arm was worked in three positions, at the horizontal for danger, half-way down for caution, and straight down for safety, but now there are only two positions, the horizontal for stop and the half-right angle for all clear, just as at night the red light showed danger, the green caution, and the white that the road was open, until in 1876 the Great Northern discarded white as a signal colour, and, doing away with the cautionary, used green for all clear, the reason being the confusion between the clear light and the lights

of the streets and houses in populous places which were few and far between, and dreadfully dull, in the days gone by The principle of the signal is not quite what might be thought Safety is assured in cases of accident by the levers being weighted so that the arm is normally at danger and remains at it until interfered with The weight has to be lifted, not released, to clear the road, and if anything goes wrong the arm automatically rises to the horizontal

The lamp is clear glass, the so-called spectacles of one green and one red glass fixed to the short end of the arm working in front of the lamp and giving the colour, both colours, it is worth noting, being obtained from oxides of copper The front of the arm, the side facing the approaching train, is red or red with a white bar, the white side, with or without a black bar, is the back, and, like the clear light of the lamp, is only of use as showing that the signal is in working order The rule of the railroad is the rule of the road, the trains on a double track passing each other to the left, but the Greenwich line was laid out for the trains to pass each other to the right, and this was the practice adopted on the Newcastle & Carlisle up to June 1863, the year after it was absorbed by the North Eastern

The ordinary signals are the home and the distant, the home having a square end, the distant having a swallow-tail The distant is cautionary only A driver must not pass a home signal which is at danger, but when a distant is against him it means he must get his engine well in hand so as to be able to stop at the home if required Another swallow-tail signal is the precaution, this generally has a ring round it, and when at danger it means that the platform at the station is already half occupied and that the incoming train must be pulled up within the space left vacant The precaution is always near the station, while the distant may be a thousand yards away on a level, though nearer on rising gradients and in places where caution is necessary All signals giving admission to a



I—L I 7

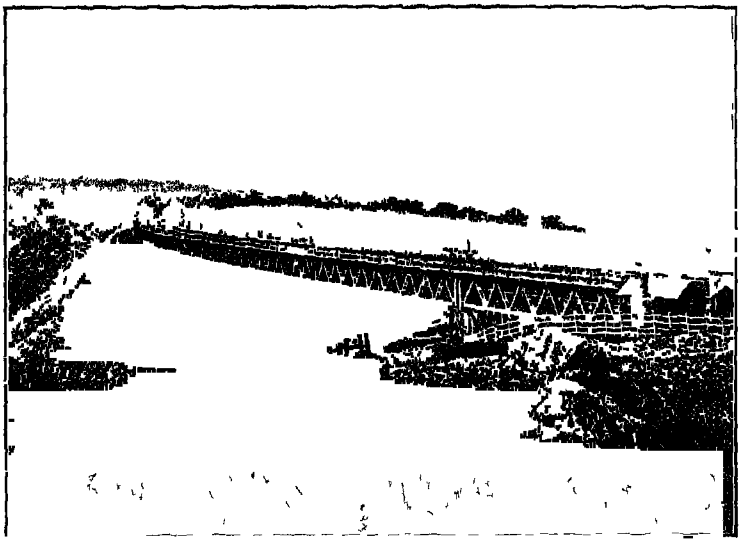
ARRIVAL OF THE SOUTH AFRICAN MAIL AT WATERLOO

section of the line are square-enders, hence the starting signals at the stations have square ends When there are two signals on the post at the end of a platform, one of which has a swallow-tail, they are worked from two different boxes, but when both have square ends they are frequently worked from the same box When one of the arms on the post is larger than the other, the smaller arm is the caller-on, this allows the train or engine to pass with caution a short distance past the ordinary signal as far as the road is clear Some signals away from stations are 75 ft high and have a 5-ft arm, but whenever a signal is over 45 ft from the ground the Board of Trade require it to have an arm lower down so as to be readily discernible, the miniature arms close to the rail level are for the guidance of the fogmen

The South Western suffers more than most lines from fog, owing to its large suburban traffic in the Thames valley In one year it has exploded nearly 120,000 fog-signals These cost less than a pound a gross, but as the food of a fogger is supplied at the company's expense, a fog of a day or two's duration may mean to a company a loss of £1000 What the total annual cost may be to the many British companies may be guessed from the fact that one firm alone, Kynochs, supply nearly two millions of fog-signals a year Cowper's detonating fog signal, then a novelty, was introduced on the London & Birmingham in January 1845, "to be placed on the rail to be passed over by the expected engine at about sixty yards distance in rear of the red signal," as the general order had it

Foggers are platelayers disguised in a thick overcoat. As their ordinary work cannot be carried on with safety in foggy weather, for in clear weather they are always busy examining the track or keeping it in repair, a man to every mile of single line, they go home, which is generally in electrical communication with the nearest signal-box, and come out in their turn for twelve hours at a stretch if necessary, half the men resting while the others are on duty.

When the arm of the signal rises to danger the fogman clips a detonator on to the rail so that the engine wheel will explode it by pressure When the arm falls the detonator is picked up and the train passes without a report Usually there are two detonators in case one should miss fire, but the code differs on different lines, though

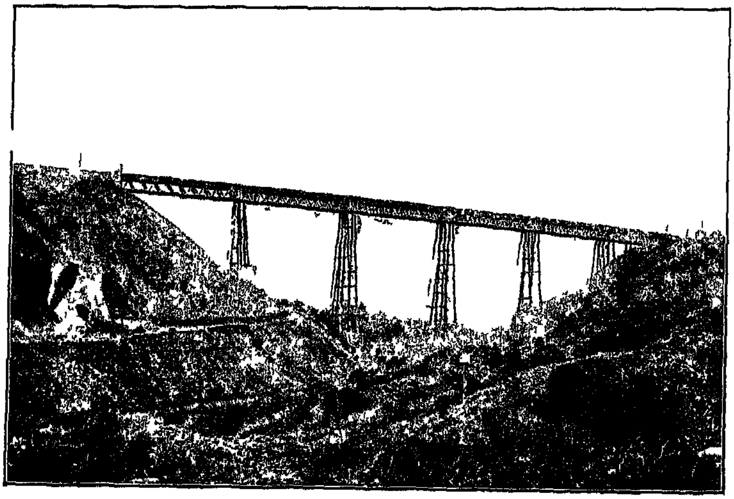


Meldon Viaduct—looking west through the cutting

on all the danger lies in silence and not in the report which shows that the fogger is awake and doing his duty

The signal itself is a large button built up of four parts, a dome of sheet iron, a base of tinplate, an anvil of malleable iron, and a clip of lead. The dome is stamped out of a 2¼ in. disk, which is pressed into the shape of a shallow basin, the base is stamped out and pressed into a lid with the rim the right size for the basin to fit into, the anvil is cast in the form of a triangle with a nipple at each corner and tinned, the lead is a strip soldered on to the back of the tinplate base. A percussion

cap is fixed on each nipple, the anvil is placed nipples downward in the dome filled with gunpowder, the base is fitted on, and the whole is squeezed together firmly and judiciously, so that there can be no shifting or leakage, and it is given two coats of paint to ensure its being water-tight A fog-signal is an explosive of which the railway



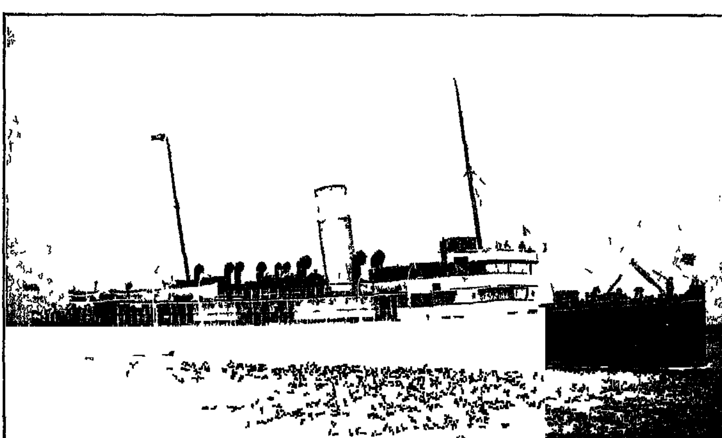
Meldon Viaduct—from the valley

companies keep as few as they can get along with, but the makers undertake to be equal to all demands at an hour's notice, and at the works the number of paper cylinders, in which the signals are packed like chocolate biscuits, is enormous during the winter months

Automatic signalling may be said to have begun in the fog, the fogging system being evidently too primitive to last for ever First came inventions for lessening the danger of the fogman's occupation when he has to look after several roads and the fog is so thick as to make it difficult to make sure of the number of lines stepped over, for in many cases signals are exploded uselessly owing to the danger in attempt-

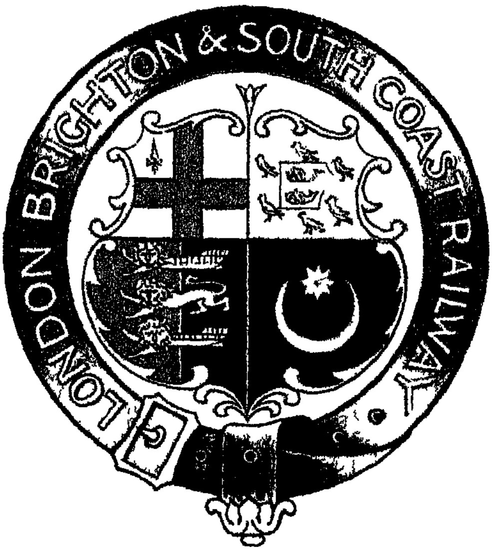
ing to pick them off when they are not wanted One of these inventions, Woodhead's, came into use in 1891, in this, by means of a lever and connecting layers, two signals are placed ten yards apart on the lines, and withdrawn if the semaphore arm is down when the train approaches

Other inventors tried to solve the difficulty on the principle of the bell instead of the knocker In the old days the noise was made at the gate to call the attention of the servants, in fact to give the summons where they were required, and all the neighbourhood heard In these days we ring an electric bell, and give the summons where the servants are waiting to receive it, and only those hear whose business it is to hear So with regard to signals in fogs Why not inform those on the engine instead of every one in the train? Why not do away with the explosion on the line and give the signal on the engine? This led to giving the signal on the engine at all times, whether foggy or not, in other words, to audible signalling, and audible signalling, as the phrase is understood, is necessarily automatic

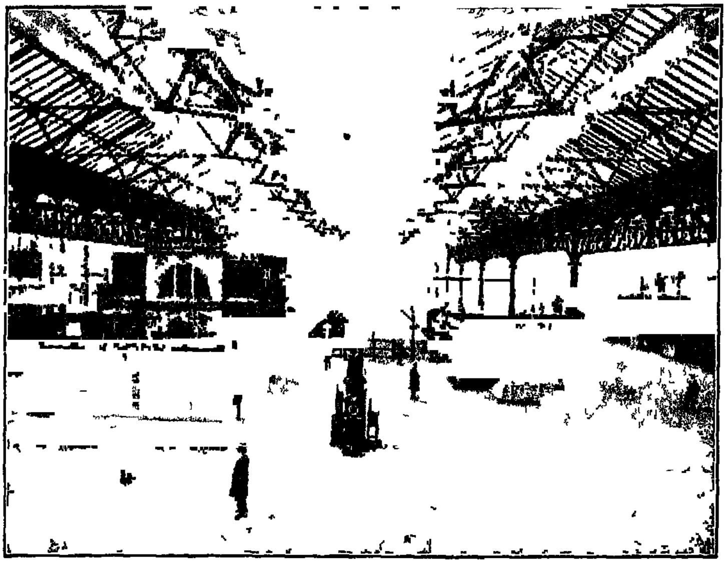


Royal Mail S.S *Alberta* of the Channel Islands Service.

THE LONDON, BRIGHTON & SOUTH COAST



COAT-OF-ARMS



Victoria Station

THE LONDON, BRIGHTON, & SOUTH COAST

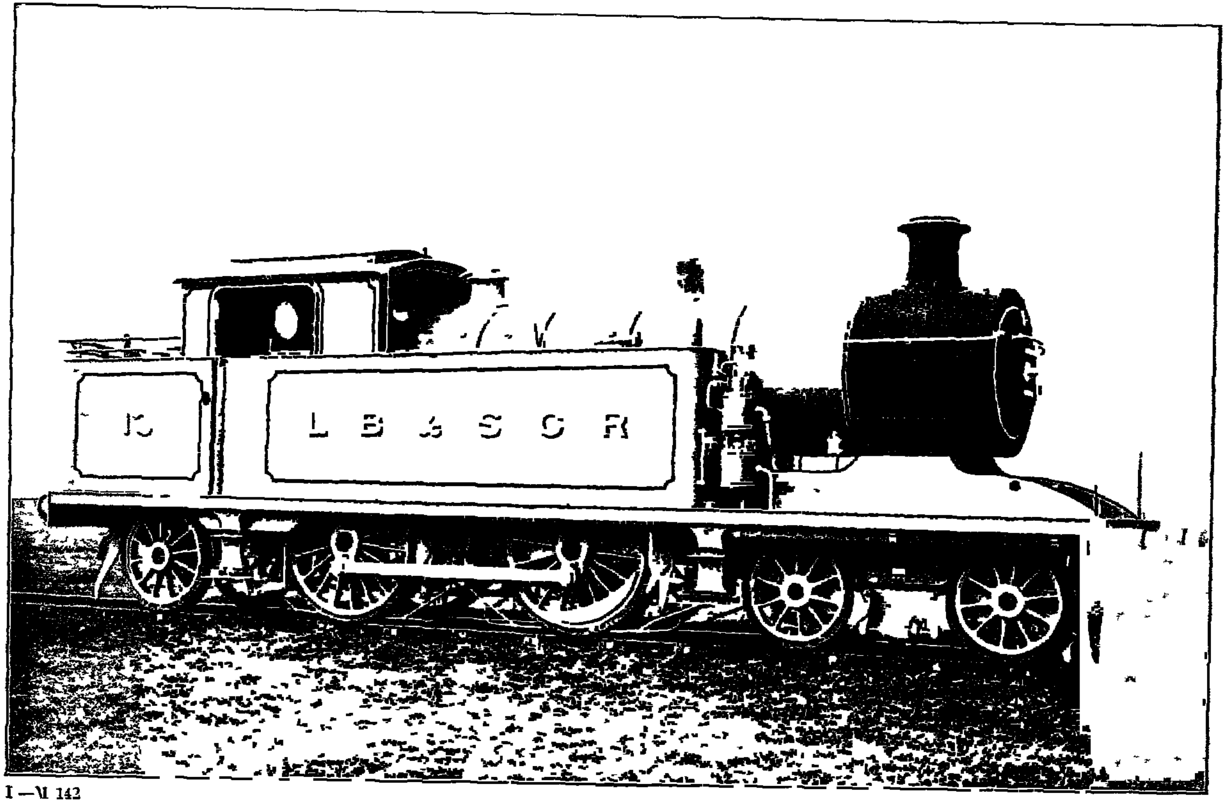
THE Brighton Railway was projected by Sir John Rennie, and it took him nine years to get the scheme adopted The airy reference to it in his autobiography lets in a flood of light on the way in which many of our railways came about "I will now," says he, "revert to 1826, the time when I was asked my opinion as to the value of railways, and I said in the most decided terms to Lord Lowther that I thought very highly of them, that they must succeed and eventually supersede every other mode of transport for passengers and goods Being quite convinced of this, with which opinion my brother George cordially agreed, I set about projecting lines to those places where I thought they were most applicable"

There were engineer's lines and contractor's lines, and

A Brighton Guard

the Brighton was an engineer's line "Another important line," says Rennie, "which I proposed at this time was one between London and Brighton" With his assistants, Grantham and Jago, he surveyed the route, placed his terminus at Kennington Park, ran to Croydon through Clapham and Streatham, and then went straight away much as the line goes now to the upper end of Brighton Further, he started Vignoles on a survey from Nine Elms through Dorking, Horsham, and Shoreham, and to this added a western branch along the coast to Portsmouth with a view to continuing to Southampton and Bristol, and when ready with his plans he got together his board, who issued the prospectus of The Surrey, Sussex, Hants, Wilts & Somerset Railway Company, which failed to make headway until it cut off its extremities and changed its name

Vignoles—afterwards Professor of Civil Engineering at University College, the first professorship of the subject founded in England—was much engaged in railway work for years, and was the inventor of the flat-based rail that found such favour on the Continent He is distinguished as being one of the youngest of our soldiers, for when a baby he was made a prisoner of war by the French, and, to obtain his release, Sir Charles Grey gave him a commission as an ensign in the 43rd when he was eighteen months old, placing him immediately on half-pay Thus Vignoles being an officer could be exchanged, and the exchange was effected without delay Nineteen years afterwards, when in his twenty-first year, he returned to full pay, and served in



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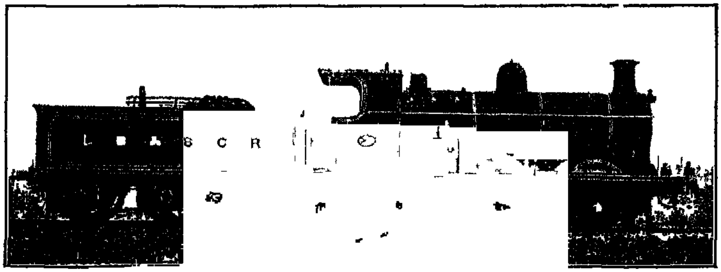
A POWERFUL 10 WHEEL TANK ENGINE. FOR FAST PASSENGER TRAFFIC

the Peninsula and elsewhere, until he returned to half-pay in 1816, when he took to surveying, his first work in Europe being this under Rennie, which was during 1825 and not 1826 as Rennie incorrectly states

Brighton in those days was growing fast and a railway to it was an obvious project, but this ambitious proposal of Rennie's did nothing beyond provoking opposition schemes, which were mutually destructive year after year, until in 1836 there were more than half a dozen routes for Parliament to decide upon These were Rennie's, which had been slightly modified and considerably curtailed, Palmer's, which went through Woldingham, Oxted, and



Goods Engine No 301

Lindfield, because he proposed to go on to Dover, that, or rather those, by Joseph Gibbs, which went from London Bridge through Croydon, southwards, that by Vignoles, which went from the Elephant through Croydon, Merstham, and West Grinstead, Cundy's, which went from St George's Fields through Mitcham and West Grinstead, and Robert Stephenson's, which went from the Wimbledon Station on the London & Southampton Railway through Epsom, Mickleham, Dorking, Horsham, and Shoreham, that is Shoreham-by-Sea

These were soon reduced to two Gibbs did not comply with standing orders, and his Bill came to early grief, Cundy's board engaged in disputes about the chairmanship

until it was too late to proceed, the Vignoles route fell out ostensibly for want of funds, and Palmer's was laughed out owing to its five miles of tunnels and enormous cuttings, some of them 120 ft deep Thus the contest remained between Rennie and Stephenson Rennie's, being the first in the field, took the shortest road. Stephenson's line was eight miles longer, but it was by far the easier, its gradients varying from 1 in 1221 to 1 in 327, and it was practically the same line that now goes from Epsom to Shoreham Rennie, who never lost an opportunity of sneering at the Stephensons, was much disturbed about this line, and in his evidence complained that his plans—which had been passing about for years—had been submitted "without my consent to Mr Robert Stephenson, whom I do not consider a proper judge of such plans!"

Fortunately Rennie had, after much effort, secured the support of the Brighton people, and Stephenson's line went through properties between Epsom and Box Hill owned by persons of influence who resisted it to the utmost, while the Gibbs lines were so placed that an arrangement could be made with their projectors if necessary And these projectors were the London & Croydon Company

The Croydon Canal, dating from 1801, branched off from the Grand Surrey near what is now Southwark Park, and ran south for about nine miles through New Cross to its basin on which West Croydon Station now stands. It had twenty-eight locks on it, and was unsatisfactory from the first owing to the difficulty of keeping an adequate supply of water at its summit level on Forest Hill It is still traceable by strips of towing-path and small ponds here and there, the largest pool being at Anerley, and so useless was it that in 1835 the London & Croydon Railway was incorporated by Act of Parliament, which bought it up, and, branching from the London & Greenwich at Corbett's Lane Junction, ran along its bed wherever possible, whence the New Cross bank up which the line now rises for over

two miles to the old canal summit at Forest Hill Next year it obtained an Act by which it had a station of its

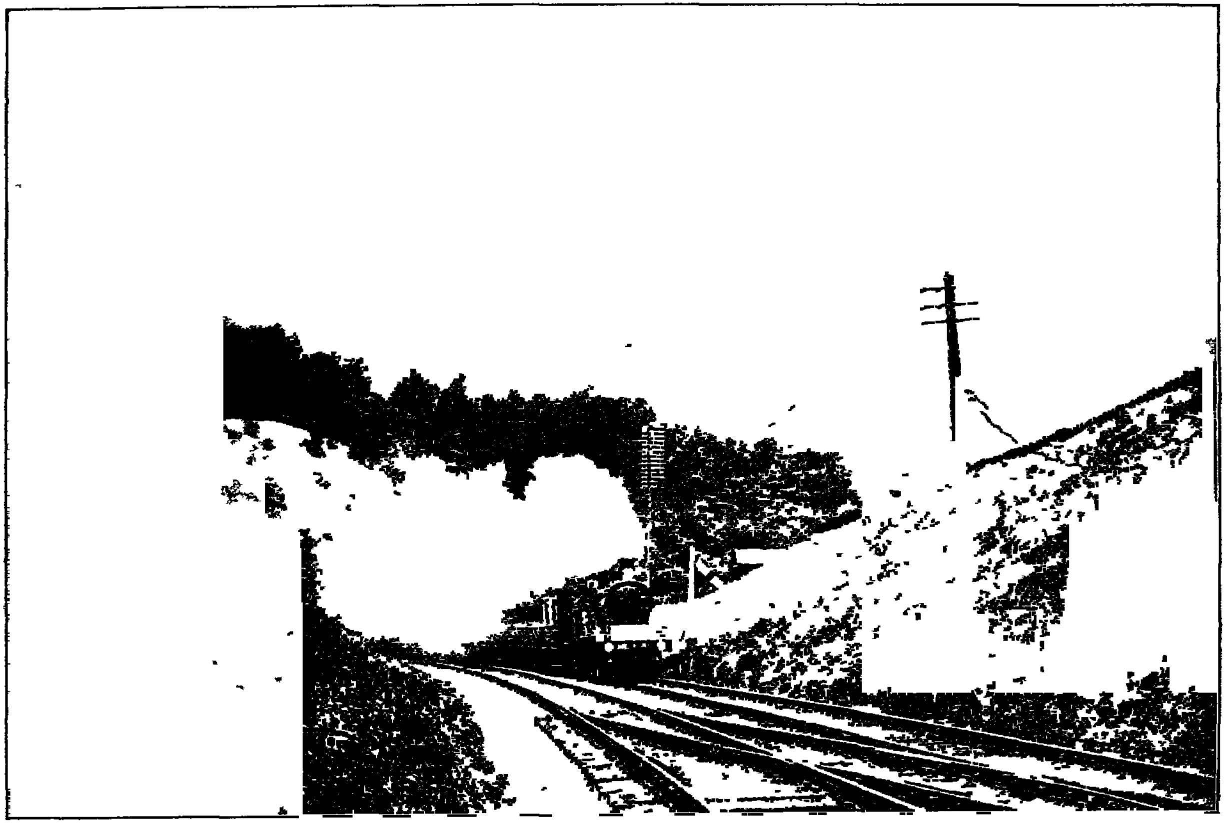
The Buffet Car of the Southern Belle

own alongside that of the London & Greenwich at London Bridge, but it used the Greenwich metals until 1842.

The first engineer was William Cubitt, who seeing that Rennie would secure a share in the Croydon traffic promptly encouraged a rival scheme Here was a line in the making—it was not opened until 1839—and Parliament not unkindly objected to damage its prospects, though its Bill had fallen out on account of a technicality

The Brighton battle created much stir, but the end of it all was that nothing was done in 1836, Stephenson's Bill being passed by the Commons but thrown out by the Lords, and in 1837 Captain Alderson was appointed by the Parliamentary Committee to inquire into these Brighton matters generally, and he reported in favour of Rennie's route with alterations not at all agreeable to Rennie Thus it came about that in 1837 the Act was passed by which the Surrey, Sussex and so on Railway, with exactly the same directorate as at first, became the London & Brighton, with branches to Lewes, Newhaven, and Shoreham, and instead of beginning at Kennington Common, that is the present Park, it had to start from Jolly Sailor on the London & Croydon Further, it had to buy up that extension of the old Surrey Iron Railway known as the Croydon, Merstham, & Godstone, which ran south from Croydon along Smitham Bottom, a few of the stone sleepers of which may still be found among the local curbstones

There was yet another and much more serious complication, due to the South Eastern Company having obtained their Act in 1836 empowering them to lay their line from Redstone Hill, that is Redhill, through the Weald by Tonbridge to Dover To give them communication with London the Brighton Company had to make the whole of the line, 12 miles 5 chains, from Jolly Sailor to Redhill, and then hand over the southern half of it to the South Eastern, who were to pay for that half with an addition of 5 per cent, the sum eventually paid being £340,000 And so, when the Brighton opened throughout on the 21st of September 1841, the train started from



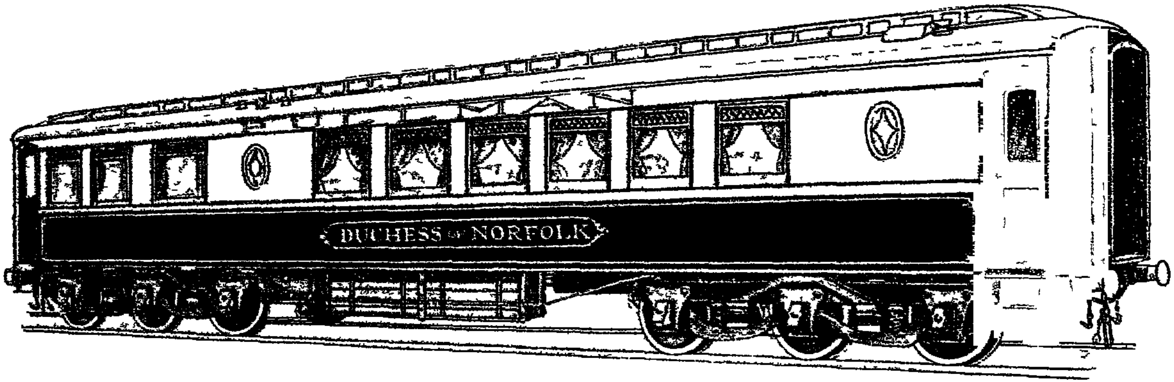
THE VICTORIA TO BRIGHTON EXPRESS AT FULL SPEED

London Bridge on London & Greenwich metals, at Corbett's Lane it ran on to London & Croydon metals, at Jolly Sailor it got on to its own line, six miles south of that, at Coulsdon, it ran on to South Eastern metals, and it was not until it left the junction at Redhill that it had any chance of going as it pleased

To add to the trouble there were gauge difficulties George Stephenson in planning the Liverpool & Manchester had arranged for a 4 ft 8½ in gauge in the Bill that did not pass To get the next year's Bill through, John Rennie was made engineer in his place While Rennie was in command, actuated by his dislike of Stephenson, he started a gauge of his own, and just as Brunel found plausible reasons for his width of 7 ft, so Rennie proved to the satisfaction of all who believed in him that the right width was 5 ft 6 in, and he began to lay the Liverpool & Manchester to that gauge Rennie's reign did not last long, and George Stephenson resumed his original position and promptly abolished Rennie's gauge Robert Stephenson in planning his proposed line to Brighton of course adopted the 4 ft 8½ in gauge, and again Rennie, notwithstanding that the trains were to run on the London & Greenwich and the London & Croydon, adopted a little gauge of his own in order to differ from the colliery lines It was something different from the Stephenson size and that was his comfort, but it was only half an inch different! Instead of 4 ft 8½ in it was to be 4 ft 9 in, and John Urpeth Rastrick, who really did the work, had to make it so Now the South Eastern did not approve of that extra half-inch, and their part had to be of the Stephenson gauge. So the Brighton trains, which were of the ordinary gauge, ran easy from the Jolly Sailor to Coulsdon, and ran easy again from Redhill to the south This nonsense lasted until the amalgamation, when Jolly Sailor was moved on a bit to become Norwood Junction, but before that took place there is another story to tell

In 1810 George Medhurst, a most ingenious man of whom few have heard, though to him all are indebted as being the inventor of the weights and scales used in every retail shop, issued *A New Method of Conveying Letters and Goods with Great Certainty and Rapidity by Air*, in which he proposed to convey goods, large or small, through tunnels by means of compressed air, and later on he published two more pamphlets on the same subject Really he covered all the ground of the subsequent patents on the matter, though he does not seem to have put any of his suggestions into practice He describes an air-tight tunnel with carriages on rails within it, either driven by compressed air or sucked by a vacuum, as patented by Vallance, and also a smaller tunnel with a piston-carriage attached by a rod passing through a longitudinal valve to a full-sized carriage running over it or alongside it in the open air, as patented by Pinkus, which may be taken as types of the two systems Vallance was simply ridiculed for his "suffocation scheme", Pinkus's Pneumatic Railway was tried near the Kensington Canal and then ceased to be heard of

In 1840 Samuel Clegg, the gas engineer, and Joseph Samuda, the shipbuilder, brought out their Atmospheric Railway project Clegg invented the valve, and Samuda built the plant and found the money In June of that year they obtained the temporary use of a portion of the then unfinished West London Railway near Wormwood Scrubbs, where they laid a tube of 9 in in diameter "The track," says F S Williams, "was of old contractor's rails, very badly laid—which, it is curious to observe, had formed part of the metals of the Liverpool & Manchester line—where on an incline of about one in a hundred and twenty a maximum speed of 30 miles per hour was obtained with a load of more than five tons, and of twenty-two miles with a load of eleven tons So successful were the results obtained during the course of the experiments



THE LONDON, BRIGHTON, & SOUTH COAST RAILWAY

PULLMAN CAR 'DUCHESS OF NORFOLK

Extreme length, 63′ 8½″ Carried on 6 wheel bogies Pullman Standard Westinghouse brake
,, width, 8′ 10¾″ Seating {20 saloon Vestibules wide open, latest type Electric lighting
Height from rail, 12′ 10¼′ capacity {12 smoking room Heated by hot water system Ventilated by revolving fans
Inside finish, vermilion wood throughout Saloon revolving chairs, upholstered olive green plush Wilton carpets
Ceilings, white and gold *Lavatory accom* Smoking room ,, dark green leather

that were here made, that the directors of the Dublin & Kingstown Railway determined on the adoption of the atmospheric principle on an extension then projected from Kingstown to Dalkey, the gradients and curves of which rendered it unsuitable for locomotives "

In this the tube was laid between the rails, firmly secured to sleepers embedded in the road On the top of the tube was a continuous opening, with vertical cheeks along it forming a trough for the valve, which was made of thick leather enclosed between thin iron plates and protected by a hinged iron lid in 5 ft lengths The interior of the tube was lined with a composition to keep the piston air-tight, and the valve was kept air-tight by a mixture of tallow and wax To the piston was attached a rod carrying rollers by which the valve was lifted so as to give room for the passage of the connecting rod that drew the carriage In front of the piston the tube was closed so that the air might be pumped out by the stationary engine at one end of the line, while behind the piston the tube was left open to admit the air by the pressure of which on the piston the train was driven Such was the contrivance that was to render the locomotive obsolete on our railways Nothing could be simpler, but it all depended on the valve

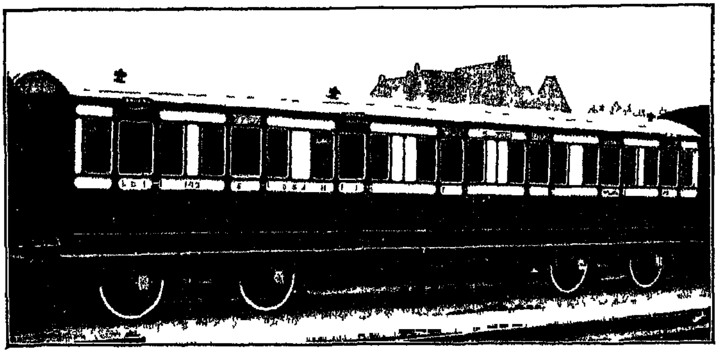
The system worked very well for a time on the Kingstown & Dalkey, while the valve was new Brunel went over to Ireland to see the thing at work, and was so well satisfied that he started the South Devon with it, and in 1845 the London & Croydon adopted it between Forest Hill and West Croydon They laid it with 15-in pipes on the eastern side of the line, although the Brighton went off to the east and had to be crossed by a curious viaduct at an oblique angle the slopes up to which were 1 in 50, a flying leap, as it was called, which the atmospherics took without lessening speed, and they went certainly 30 miles an hour, some said 60 But the time

of tribulation came next year, when the sun was so hot that it melted the tallow and wax that kept the valve air-tight, and, try all the inventors could, no suitable composition could be hit upon, and the valve began to wear out and the air escape from it even in cool weather, and, as on the South Devon, nothing could be done And there is nothing left of it but a few pipes discoverable now and then, while Medhurst's other plan, tried in the Pneumatic Despatch, survives in the tubes used by the Post Office telegraphs, the carriers of the British Museum library, and many of our factories and shops

In July 1846, the year the atmospheric experiment was abandoned, the London & Croydon and the London & Brighton were amalgamated and became the London, Brighton, & South Coast, the south coast lines having then been extended to Hastings in one direction and to Chichester in the other In the following year the western line was opened to Portsmouth, and the three extremities of the system had been reached In December the Newhaven branch was opened, and the Brighton started its cross-channel work, London to Paris in twelve hours, a journey it now does in less than nine

The Crystal Palace was opened in 1854, and to it the branch was run from Sydenham, which began working on the 10th of June in that year, then the only means of access by railway The continuation of that branch to New Wandsworth opened on the 1st of December 1856, on the 29th of March 1858 the line was opened to Battersea, afterwards Battersea Pier, a passenger station, like New Wandsworth, that no longer exists, two years afterwards it reached Pimlico, and soon after that it was at Victoria Pimlico has gone, like many other stations, for there is no company that has made more changes in its stations and their names Dartmouth Arms became Forest Hill, Jolly Sailor, Norwood Junction; Godstone Road, Caterham Junction and now Purley, Greyhound

Lane, on the line from Croydon to Balham, opened in 1862, has become Streatham Common Yapton, between Barnham and Ford, has gone , so has Woodgate, between Chichester and Ford , so has old Littlehampton, between Angmering and Ford , so has Keymer Junction, and quite a number of old stations have been absorbed in new ones, the last and largest being Victoria



A Composite Carriage

In 1847 the branch was opened from Croydon to Epsom This went on to Leatherhead in 1859 Meanwhile Horsham had been reached through Three Bridges in 1848 , from Horsham to Petworth had been opened in 1859, and from Hardham Junction, near Pulborough, to Ford in 1863 From Petworth to Midhurst the connection was made in 1866, but the endeavour to reach Southampton having failed, the line was run south from there to Chichester in 1881 to form the western boundary All that remained to be done on this side was to join up between Leatherhead and Horsham in 1867, and the company obtained their Mid-Sussex route to Portsmouth

In 1865 the line was opened from Sutton to Epsom Downs. This gave the company a route to the Derby, etc , up to then a monopoly of the South Western, and it went right on to the course, an improvement of which the public were

not slow to take advantage Seven other racecourses are on the Brighton system, Lewes, Lingfield, Plumpton, Gatwick, Brighton, Portsmouth, and Goodwood, so that the racing folks, and the horses, add an appreciable item to its revenue

The line to Guildford from Horsham through Cranleigh was also opened in 1865 On the other side the route to Eastbourne started with the line from Eastbourne to Hailsham as far back as 1849, and the line from Lewes to Uckfield nine years later These joined at Redgate Mill in 1880, the Uckfield and Groombridge line having been completed in 1868 The next step was to connect Groombridge with Oxted, the Oxted & Croydon being the joint property of the Brighton and the South Eastern Thus the system serves Surrey and Sussex with just a little strip of Kent and a corner of Hampshire, and you are told by its coat of arms that its chief towns are London, Hastings (the Cinque Port), Portsmouth (with the moon and star), and Brighton (the two dolphins), which is in the county of Sussex (the shield of martlets on which the inescutcheon of Brighton is borne)

It starts in Middlesex, at Victoria, and its trains have run for brief periods into Cannon Street and into Paddington, and they also appear north of the Thames under a partnership in a railway that has no shareholders, no loans or debentures, and publishes no accounts In 1836 there was incorporated the Birmingham, Bristol & Thames Junction Railway from Harlesden Green to the Kensington Canal, which entered the Thames at Chelsea Creek The engineer and projector was William Hosking, and it was his intention to continue the line east from Kensington Crescent to Knightsbridge as the terminus, and south to Wandsworth so as to join up the North Western, Great Western, and South Western. On its way from Harlesden it ran under the Regent's canal to cross the Great Western on the level, and the arch by which it did so, now blocked up, can be seen on the right hand as you

leave Paddington, just as you pass under the West London Railway bridge

After a precarious infancy it became the property, in 1840, of the Great Western and North Western, who used it as their link between north and west They did away with the level crossing, and brought the line over the canal and over the railway and made a junction with the Great Western metals on the south side, and they changed its cumbrous name to The West London As no one cared about the part south of the junction, there was no hurry in finishing the line, and it became a stock subject for *Punch* to print paragraphs about, and came in useful for the atmospheric trials and similar things In 1863 it was completed to Addison Road to meet the West London Extension that went on from there with the mixed gauge to Clapham Junction

Of this line the North Western owns a third of the capital, the Great Western a third, the South Western a sixth, and the Brighton a sixth, and there is no rolling stock, the West London being, officially, worked by the Extension which is worked by the owners The Brighton was the company most interested in the matter, as they had no other route across the Thames, while the South Western could get across more conveniently farther up, and the other companies were a long time finding out what could be done with this useful link, though they put certain restrictions on their junior partners

Through the Thames Tunnel (that is the old tunnel of the Brunels) runs the East London, by which the Brighton also crosses the river This line is leased to the Great Eastern, the Brighton, the South Eastern & Chatham, and the Underground, and the reason of all this is coals It is down the lift at Whitechapel and through the tunnel that the coals come south People who complain about the expenses of the Brighton forget that it runs to no coalfield and pays for the freight of all the fuel it uses, which means

that it has to pay maybe half a sovereign a ton more than the north-going lines, and half a sovereign per ton represents about £125,000 per annum, equal to £1, 2s 6d in dividend on the ordinary shares Coals, household and otherwise, and heavy goods, it deals with also at Deptford, as it does miscellaneous freight at Battersea, its two riverside terminals

It has its ports, of course, but they are not large The most important of these is Newhaven, Shoreham is in a small way, Littlehampton, from which the company's steamers used to go to the Channel Islands and Honfleur does but little trade, and Portsmouth is mainly used for communication with the Isle of Wight At one time something was to be done with Langston Harbour, the trains being run on to the *Carrier* and ferried across Spithead to Bembridge, but that clumsy-looking boat was useless in anything of a breeze, and is chiefly remembered as a curiosity up Newhaven river In short, though the Brighton serves every seaside place between Hastings and Southsea, its only port worth mentioning is Newhaven; and altogether it deals with only about 1½ million tons of merchandise and 3 million tons of minerals, which together produce under £900,000 out of a revenue of nearly 3½ millions

The Brighton is what most people think a railway ought to be Its passenger element is predominant, and its goods trains and coal trains do not obtrusively interfere with its passenger service In merchandise traffic the public take no interest, and will not understand its importance to the company's welfare, and nearly all the talk is of passenger engines, passenger trains, and passenger fares

It depends, then, on its passengers, and it really does its best for them; and the way it brings its patrons into London and distributes them in the evening to the country places it has encouraged throughout its territory by means of its season-ticket system, deserves more praise than it gets The policy of the season ticket is clear enough In the first place, it secures the holder for the line and ensures a regular load for

the trains, in the second place, the difference between its cost and that of the necessary ordinary tickets is the sprat that catches many a mackerel It means that the holder's family,

The Drawing room Car of the Pullman Train

the friends of the holder's family, and the tradesmen who supply that family will all become customers of the line.

The revenue from the Brighton season tickets averages £643 for each of the 487 miles of its system How it comes to be possessed of such a mileage, considering that the distance from Victoria to Brighton is 50 miles 52 chains, and from London Bridge only 21 chains more, is rather a puzzle, until it is remembered that it has no less than seven outlets to the south coast, ten coastal termini, and a road right across the middle from Tunbridge Wells to Guildford The main line is the easiest south of London, rising to Merstham, dropping to Horley, rising to Balcombe, dropping to cross the Ouse viaduct and rising to the Clayton tunnel, the longest grades being 1 in 264 Out of the fifty miles it rises generally for thirty with a few short lengths that are rather steep, the worst being the 1 in 64 for three-quarters of a mile to cross the Thames The other roads are not so favourable There are gradients of 1 in 60 between Sydenham and the Crystal Palace, and between Sutton and Epsom on the Portsmouth Road, and the worst is the two-mile rise of 1 in 50 between Mayfield and Heathfield on the eastern boundary, south of that little spur line where the engines go to become cold and dead and covered with leaves like the babes in the wood

The old troubles due to the South Eastern using the same track to Redhill were done away with when the new line was made from South Croydon to Earlswood, a pretty piece of engineering with its substantial bridges and deep cuttings and the new Merstham tunnel of 2113 yards, 283 yards longer than the old one though not the longest on the line Two tunnels, both of the same length, 2266 yards, are a little longer, these being Oxted and Clayton, the latter of which was lighted by gas until the accident there in 1861, to which we owe the introduction of lights into railway carriages The widening of the line to Croydon has also had a good effect on the running, which will be still further improved by the changes at Clapham Junction to clear the way for the full operation

of the new methods introduced in the transformation of Victoria

Old Victoria, with its wonderful arrangement by which every line seemed to cross every other line, covered $8\frac{1}{2}$ acres, the new Victoria covers nearly 16 It is 320 ft wide, 1500 ft long, and has $2\frac{1}{4}$ miles of platform In its making the features that will be best remembered were the driving of the piles over the old circulating area, 1200 pine

The 60 ft Turntable at Victoria

balks 14 in square and from 38 ft to 45 ft in length driven down with a 27 cwt monkey to give a firm foundation for the new offices and the hotel extension on the brashy, treacherous ground where there used to be the basin of the canal, the damming of the Grosvenor Canal at Ebury Bridge, and the filling up of its bed, and the clearance of the eight acres of land along the Buckingham Palace Road before the building of the handsome wall and noble arch that are among the sights of London

The lofty, well-lighted booking hall and waiting and refreshment rooms are of a new type, and the circulating area of over half an acre is equal to more than double the space owing to the admirable arrangement of lifts and subways by which the luggage disappears below as soon as labelled in the hall and only comes into view again opposite the van in the train Worked in the same way is the capacious cloak-room with its 28-ft counter and partitioned shelves that would very greatly have astonished the stationmaster at Bath who began the left luggage system seventy years ago In short, the transit of the porter with the truck is invisible at Victoria

As is the fashion nowadays, there is a clock-face indicator—eighteen faces, one to each platform—and an inquiry office to relieve the booking-clerks and ticket-men from the seeker after knowledge whose mission in life is to block the way And the clearing of the platforms half-way by the Eccleston Bridge prevents half the arriving crowd from hindering the departing

With platforms of such length, and three sets of rails between them in the outer half, the eighteen trains thus accommodated can be worked in and out without delay The thirteen lines become five outside the station and over the Grosvenor Bridge, which used to be the widest we had, and has been further widened by the Brighton on one side and the Chatham on the other The fifth line is a carriage and engine road from the sheds, and soon after the bridge is crossed the roads become the standard four

When Mr C L Morgan was planning the new station, which took seven years to complete and cost over a million of money, the statistics he collected showed that the greatest number of trains dealt with in a day was 700, that the old station was used by 18 millions of people in a year, of whom 58,474 passed through in the twenty-four hours during which the count was made, and he has doubled the accommodation and more than doubled the facilities, quite irrespective of the gain made by the new signalling

This is on Sykes's electro-mechanical principle, first used at St Enoch's The electrical levers being

On the way to the South Coast

smaller than the mechanical, the signalman has them more easily within his reach, and, there being no signal

wires, the cabins can be half the size of the corresponding ones of the old style So compact is the arrangement that it is difficult to understand how so much can be got into the space There are three cabins, the North Box, the South Box, and the Shunting Box The North Box, which is 28 ft by 10 ft, contains no less than 106 levers, of which 83 are electrical, the South Box is 60 ft by 14 ft, and contains 269 levers, of which 163 are electrical, the small Shunting Box, 16 ft by 12 ft, has 22 levers, of which half are electrical The man in the North Box is the watchman of the station it is his duty to observe and control the whole of the platform movements, while the man in the South Box does the sectionising, and the Shunting Box deals with the marshalling in the sidings, where a prominent feature is the big turntable 60 ft in diameter

All the passenger roads have electrical fouling bars distributed in such a way that every train standing in the station must be on one or more of them, and these control the signals for opening or closing the road, a novel feature being the movable diamond crossings worked from the South Box, the movements of which are also detected by the signals In each box is a plan of the station, and there is also an indicator with a double row of miniature arms, nine in a row, the upper arms being for the inner station, the lower arms for the outer The inner home signals have distants below them, and if the road is full up, both work, if only half the road is engaged, the upper one is down The signals have what is known as a red banner carried on a disk with an opal glass at the back, behind which is an oil-lamp that can burn for a week, if necessary, without attention, and the opal glass allows the signal to be seen as well by night as by day. The semaphore signals are pulled off by an electric motor In the illuminated signals the spindle is not in the centre, and consequently the banner moves back to normal as soon as the current is broken The neatness and quick-

ness of it all need not be enlarged upon On the first day the new signalling came into operation there was confusion owing to the fouling bars requiring adjustment, and passengers learnt to their sorrow what a railway without signals was like, but this was soon put right, and there has been no trouble since

Having adopted electricity for signalling, the Brighton proceeded to introduce electrical working for its trains, and began the electrification of the South London This meant the special equipment within the station of five platform lines and two through roads, and the installation all the nine miles to London Bridge of the overhead system on a new sort of support, an undertaking of some difficulty owing to the low bridges and the curved tunnels at Denmark Hill, and the nature of the embankments, some of which had to have piles driven in to give a firm foundation

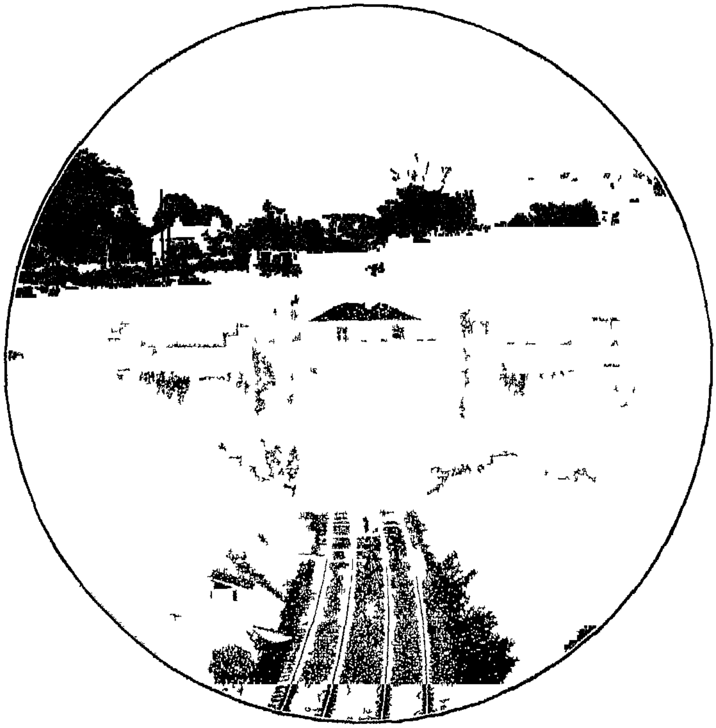
The conductor, a heavy, grooved, solid half-inch wire, is, unlike most we know of, supported at every few feet by dropper wires hung from two-stranded steel cables hanging from large porcelain insulators through a double insulation tested to ten times the working pressure; and it is divided into sections at each station, so that any section can be isolated when required The current collector bow is not of the fishing-rod type but a collapsible framework, the result of much endeavour to find something that would work satisfactorily at high speeds within a vertical range of 7 ft., the height of the conductor varying between 14 and 21, the latter at the terminal stations where the men have to work on the roof of the train

The current comes to Queen's Road Station from the London Electric Supply at Deptford, and is certainly treated with respect, for never before were such precautions taken to switch it off at any accidental attempt to get near it Even in the coaches the secret cupboard is only accessible to the railwaymen when all high-tension con-

nections are earthed, for the door cannot be opened until all is safe within This is the smartest of the electric lines, but then the Brighton can be very smart if it likes, and not only do the long 60-ft coaches look well in the new colours of the company—popularly known as chocolate and cream—but they are well arranged and easily entered

How smart the Brighton can be is shown by that excellent train the Southern Belle, designed complete to be "the most luxurious train in the world." Here are seven cars, built by the Pullman company, each car 63 ft 10 in in length, that is to say it is a train 500 ft long with the engine, and it is seated to hold 219 people It is heated with hot water, and installed with electric bells, electric light, and electric ventilation, and its interior decoration is as good as money can make it You can take your choice of the Grosvenor car with its quiet Adams treatment of mahogany and satinwood, and its green morocco chairs and settees, or of the Cleopatra—in the Pergolesi manner—with its satinwood and sycamore, greenwood and tulipwood and box, and its profusely decorated panels, pilasters, and friezes, and take your ease in its velvet chairs, in soft blue touched with gold, that harmonise so well with the deep rose carpet, or of the Bessborough with its striped mahogany and satinwood and kingwood trellis, and try its drab cloth upholstery, or of the Princess Helen with its plum-pudding mahogany framed in purple kingwood, and its comfortable chairs in green and drab striped moquette, or of the Belgravia—Pergolesi again—with its pear and holly inlays, and its blue velvet sofas and seats, or of the Albert or Verona—Renaissance these—with the cabinet work in wainscot oak and holly, and the upholstery in coffee colour And when you are tired of the view through the windows, that come down nearly to the floor, you can look at yourself in the mirrors which some people seem to delight in It is a handsome train, well worth the twelve shillings, that is less than three-

halfpence a mile, for the double ride in it, and it travels well, giving a really comfortable run of the fifty miles within the hour, which is not so bad considering that the end of its journey is its first stop out of London and it cannot



Clayton Tunnel

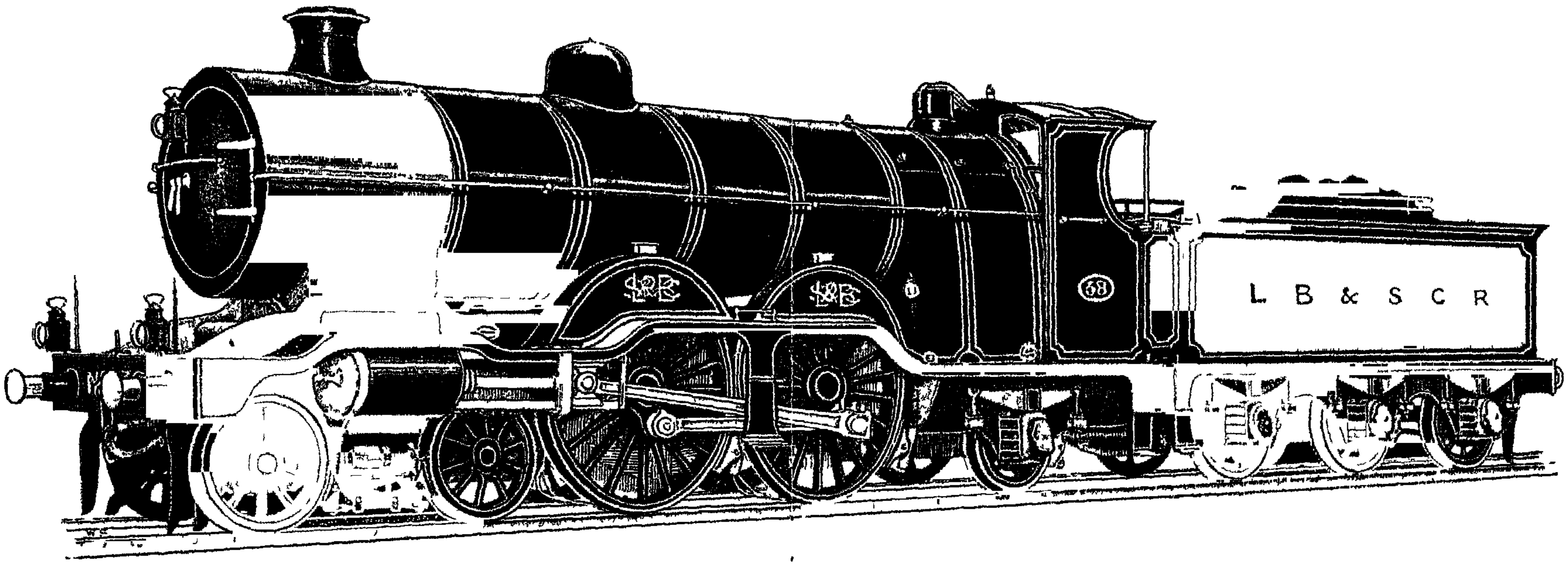
let itself go until it passes Purley, but it will move faster when the time comes

The same can be said of the 8 45 out of Brighton, which is not so richly decorated but just as good for the average man, and it is a noteworthy train, for it was the first on which breakfast was served, the car on the down journey being used for afternoon tea, and that is going back some

years, the Brighton having begun to run Pullman cars in 1879 This 8 45 train weighs 336¾ tons, made up as follows first-class brake 25½ tons, first-class coach 27 tons, first-class coach 28½ tons, three Pullmans 28 tons each—84 tons—first-class coach 27 tons, first-class saloon 26¼ tons, first-class saloon brake 26½ tons, first-class brake 25 tons, Pullman car 40 tons, first-class coach 27 tons Add to this 12¼ tons as the estimated weight of the passengers, and we have 349 tons There is an object in giving these particulars, for the train is now frequently worked by one of Mr Marsh's wonderful tank engines, which run their 200 miles on 3½ tons of coal

Let us take No 21 It weighs 73 tons Thus the 8 45 with engine complete weighs 422 tons These tanks are the heaviest engines on the line, the Atlantics that usually work the Southern Belle weigh 67 tons, that is 96½ tons with the 29½-ton tender The boiler is 10 ft 9⅞ in long and 4 ft 10 in in external diameter, the cylinders are placed at an inclination of 1 in 9½ and are 19 in in diameter and have a 26-in stroke, the firebox is 7 ft 7 in externally and 3 ft 4$\frac{1}{16}$ in wide, the heating surface is larger than in any other tank engines, the tubes giving 1499 and the firebox 126, making up 1625 sq ft, the grate area is 24 sq ft, there are 315 tubes of 1⅝ in in diameter and 11 ft 2$\frac{1}{16}$ in in length, the bogie wheels measure 3 ft 6 in., the trailing wheels 4 ft, and the coupled driving wheels 6 ft 9 in The trailing end is carried on a 2-wheel truck, the frames are 37 ft 5½ in long, and are spaced at 4 ft 8½ in until within 6 ft 6 in of the hinder end, when they close in to 3 ft 3½ in so as to allow for the clearance of the trailing wheels on curves, and in front they are cut away from the bogie wheels Pearson's Bristol & Exeter tanks would have made a very poor show alongside these 73 tonners that occasionally take the 11 o'clock (314¾ tons) down to Brighton in fifty-five minutes

The first two engines used by the Brighton company



THE LONDON, BRIGHTON, & SOUTH COAST RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 38

DESIGNED BY MR D EARLE MARSH M INST C E

BOILER	Length	16′ $3\frac{3}{8}$″
	Diameter	5′ 6″
CYLINDERS	Diameter	1′ $6\frac{1}{2}$″
	Stroke	2′ 2″
TUBES	No	246
FIRE BOX	Length	5′ 11″
	Width	6′ $9\frac{1}{4}$″
HEATING SURFACE	Tubes	2318 sq ft
	Fire box	141 ,,
	Total	2459 sq ft
DIAMETER OF WHEELS	Bogie	3′ 6″
	Coupled	6′ $7\frac{1}{2}$″
	Trailing	3′ 6″
GRATE AREA		31 sq ft
WORKING PRESSURE		200 lb per sq inch

		Tons	Cwt
WEIGHT IN WORKING ORDER	Engine	67	0
	Tender	39	10
	Total	Tons 106	10

WATER CAPACITY	3500 galls
COAL CAPACITY	4 tons

were the Merstham and Coulsdon, and they weighed when empty 12½ tons. Of them and their successors the story is told in detail in that excellent work *The Locomotives of the London, Brighton, & South Coast Railway*, in which there seems to be a record of every one from the beginning to 1893, not at all an easy task considering the bewildering way in which names and numbers were shifted about. The London & Croydon list, which was soon cut short by the amalgamation, went back to 1838 with the Surrey, Sussex, and Kent, all, however, of 12½ tons. Up to 1849 the Brighton engines were lagged with polished mahogany and bound with brass, or the lagging was plain wood painted red and green in alternate stripes; up to 1870 those that were not polished were painted Brunswick green banded with black and thinly lined with white, the frames being crimson; then they were painted gamboge, and now they are umber brown.

Of some of the old engines there are interesting stories. No. 82, for instance, on the 6th of June 1851 was running down the incline between Falmer and Lewes when it ran off the line at the Newmarket Arch, and, dragging two carriages with it, fell into the bridle-road below, killing three of the passengers and the fireman on the spot. The reason was that a shepherd boy had placed a sleeper across the north rail. The boy was tried and the jury found him not guilty. Twelve months afterwards, on the same day of the same month, at the same spot where that sleeper was put, the same boy was killed by a stroke of lightning.

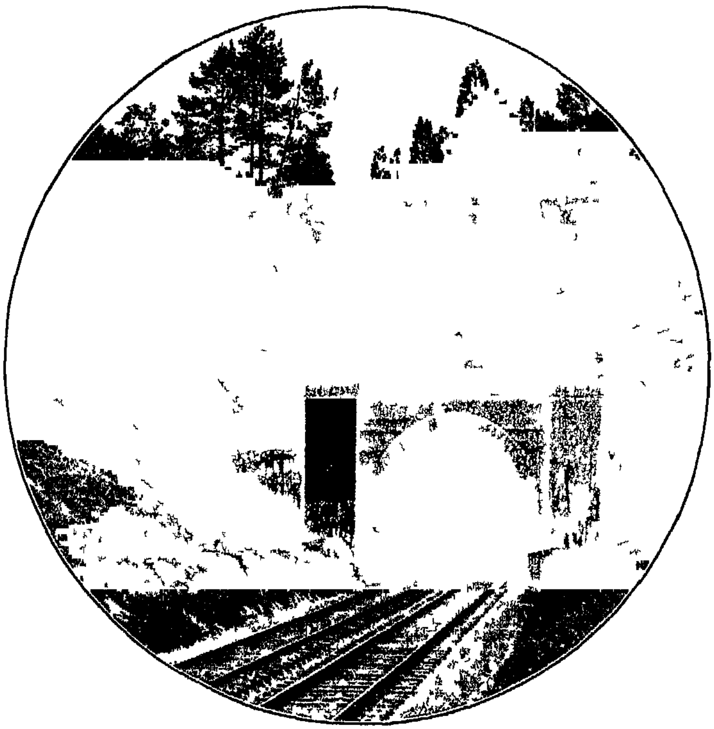
No. 79, one of the same class, had a curious adventure in October 1859. At five o'clock in the dark morning she was in the shed at Petworth, when, the fire having been put in two hours before, she had 15 lb. of steam. The cleaner wanted to move the engine to clean certain parts he could not get at in the position she was placed, and he went out to ask the fireman, who was resting in a hut close by, to do this. As he came back he heard the beat of

an engine, and, thinking another one was coming, ran back to the fireman to tell him he need not mind, as the newcomer could do what was wanted. The fireman, however, was just starting, and the two returned to the shed to find that the engine had disappeared! Looking along the line they caught sight of the steam; and they ran off in chase. The engine was moving so slowly that they nearly caught her, the cleaner getting his hand on the buffer when he fell from exhaustion. The fireman collapsed when close behind; and No. 79 went on her way, gaining speed as she went for 17½ miles, crashing through three sets of gates at level crossings and carrying off pieces of them on the buffer beam. Fortunately a cleaner from Horsham who was walking down the line saw the engine approaching, and thinking from the wreckage on the buffers that something was wrong, watched to see who was on the footplate. Finding nobody, he jumped on to her as she passed and shut off the steam just in time to prevent any further damage being done.

These engines belonged to a class of twelve supplied by Sharp, Roberts & Co. in 1847 and 1848, the company building none of its own until 1852. The older ones were most miscellaneous. Four were built by the Rennies; seven were built by Bury; three came from the Fairbairns; one, from J. G. Bodmer, had two pistons to each cylinder which worked simultaneously in opposite directions; four came from the Hawthorns; four long boilers came from Jones & Potts; thirty from Sharp; a dozen from Hackworth, which had inside boxes for the driving wheels and outside boxes for the leaders and trailers, being the predecessors of the Jenny Linds; and nine came from E. B. Wilson.

The first superintendent to produce a home-made, Brighton engine was Mr. J. C. Craven. This was No. 14, a tank 2–2–2 with 13 in. cylinders and a 20-in. stroke, the length over all being 24 ft. 6 in., and the weight, with 625 gallons in the tank, 25 tons. Ten years afterwards, after a series of what were practically samples, came the

introduction of the well-known Brighton type with the leading and driving wheels coupled The first were Nos 155 and 156, and they had 16 by 20 cylinders, and weighed 26 tons 14 cwt Next year came the London and the Brighton with cylinders 17 by 22 and 84-in driving wheels,

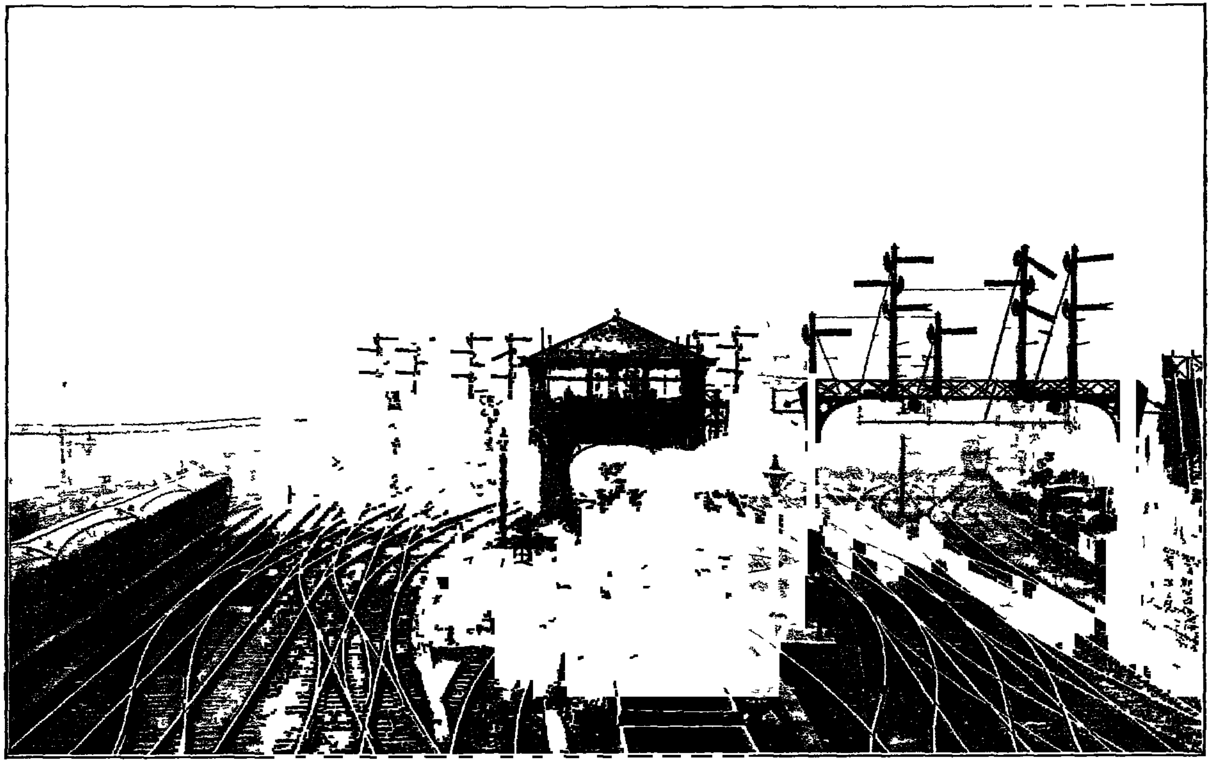


Mickleham Tunnel

the largest ever used on the line. their heating surface was 1238 and their weight 32 tons 11 cwt These were followed by Nos 172 and 173, the first of these being afterwards named Chichester, while the other became the first engine to be painted yellow This Chichester was scrapped in 1886, the Chichester that followed in 1887

being one of twelve built by Robert Stephenson & Co in 1864, among which were the Paris, the first engine named by Mr Stroudley, and the Sussex, which after being re-built in 1871 was well known as the fastest on the line As altered, she had 17-in cylinders with a 23-in stroke, a heating surface of 1288, and weighed 36 tons 6 cwt

When Mr Craven was succeeded by Mr Stroudley in 1871, he is said to have left behind him no less than seventy-two classes of engines, and Mr Stroudley increased them by his alterations and repairs until he found sufficient reasons for clearing most of them out The first he built of his own design were two 6-coupled goods engines, Nos 84 and 85 These had 17½ by 26 cylinders, a heating surface of 1414, and a weight of 38 tons 12 cwt In October 1872 he put on the line the Wapping, the first of his famous fifty terriers, the last of which, Crowborough, appeared in September 1880 Originally these had 13-in cylinders, but the last had them of 14 in, and many of the others had this size put in afterwards to the improvement of their appearance, for a 13-in terrier had hot water in the tank which burnt the paint off, while in the 14-in ones the whole of the exhaust went up the chimney, and the boiler was fed with cold water These small 6-coupled tanks were much more powerful than might be supposed One of them, the Brighton, gained a medal at the Paris Exhibition in 1878, and bore a notice to that effect painted on her tank for many years While she was in France the Brighton representatives inquired if the Ouest company, which then owned the route from Dieppe to Paris, would quicken up their service a little "To what speed?" asked the Frenchmen "Forty miles an hour at the least" "Impossible! No engine can do it on our road" "Yes, the Brighton will" The Frenchmen being incredulous, the little engine was put in steam and hitched on to the French train, and away she went from Paris to Dieppe with the directors on board at nearer fifty



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A BUSY SCENE THE APPROACH TO THE TERMINUS AT LONDON BRIDGE

than forty. And the Ouest woke up and has continued to go ahead although it now belongs to the State.

These terriers had 4-ft wheels, the piston stroke was 20 in., their heating surface was 518, their length was half an inch over 26 ft., they carried 27 cubic ft. of coals and 500 gallons of water, and their weight in working order was 24 tons 7 cwt. They were the A class. The D class proved just as useful, and there were 125 of them, the first being the Sydenham in 1873. These 0–4–2's with 66-in. coupled wheels and 54-in. trailers weighed 38½ tons, and were 31 ft. 7½ in. long, and they were given 17 by 24 cylinders, a heating surface of 1043, and worked at a pressure of 150. About a year after their first appearance Mr. Stroudley built the Grosvenor, his first single express; those who would know all about that famous engine, inside and out, will find it in *Locomotive Engine Driving*, by Michael Reynolds, a detailed study in which every part down to the minutest is shown with its working and inter-working. She is a 2–2–2 with 81-in. driving wheels, weighing 33 tons, and in her long life there seems to have been no work on the line she was not tried at and could not do.

Meanwhile he had started his 6-coupled goods tanks of the E class, of which there were 72. After these, in 1876, came the D 2's designed for the fast fruit traffic from Worthing, and the express goods from Newhaven, and found so useful that they were put on to excursions and general passenger work. Finding front-coupled engines in every way suited to his purposes, he introduced the D 3 class—Richmond, Devonshire, etc.—for his Brighton and London expresses. These were given 78 in. coupled wheels, cylinders 17½ by 26, a heating surface of 1182, and weighed 36 tons; the Gladstone, or B, class followed in 1882, with cylinders of 18¼ in. by 26 in. in one casting, a heating surface of 1485, and a weight of 38¼ tons. The Gladstone's cost £2550 each, and there are 36 of them.

On Mr. Stroudley's death in December 1889 Mr. Bil-

linton took his place, and soon began to design engines more suitable for the heavier traffic all of them easily known, as, unlike the Stroudleys, they have no copper caps on their chimneys In 1891 came the tanks with four wheels coupled and the trailing bogie, the heating surface being 1203, the weight 48 tons 9 cwt , and the pressure 160 , then came the six wheels coupled, 0–6–2 radial tanks with 54-in wheels, the trailers being 48 in , sixteen of these were put to work, and then followed the somewhat similar class with 60-in wheels In June 1895 came the Charles C Macrae, the first of a new class of 4-coupled expresses with a leading bogie This was turning the Brighton type the other way round, and the wheels were in a different proportion, the bogies being 42 and the drivers and leaders 81 The boiler was 10 ft $7\frac{1}{4}$ in by 4 ft 5 in The Bessemer of 1898 was of this type, with a boiler of 4 ft 8 in , and next year there appeared the Siemens, the first of a powerful class with 19 by 26 cylinders, 1635 heating surface, and a boiler of 4 ft 10 in diameter There were twenty of these, including His Majesty, Emperor, Empress, and others well known to the passengers by the line They weigh 49 tons, nearly four times what the first engines did, and have a heating surface more than three times as great This was in 1902, and now with their successors, which are nameless—and a good thing too if their names were to be those of stations—we have reached 67 tons for tender engines and 73 for tanks , and the number of engines is about 550, and that of the vehicles they draw is over 13,000.

That the Brighton engines are fitted with the Westinghouse brake everybody knows by the pumping that goes on while they are at rest in a station The donkey-pump by the side of the engine is pumping air into the main reservoir beneath the engine until it is at a pressure of from 75 to 80 lb By means of the driver's brake-valve that air will be turned into the brake-pipe—the pipe that hangs in a loop between the buffers—extending from

carriage to carriage all along the train. Communicating with this under each carriage is a small reservoir in which the compressed air is stored, and in communication with that is the brake-cylinder by its side containing a piston and rod by means of which the four blocks are applied to each wheel. What happens is, that so long as the pressure is uniform the brakes are off, but as soon as air escapes from the brake-pipe a triple valve under the carriage admits compressed air from the small reservoir

The Boat train leaving Lewes

to the cylinder, which brings the piston and rod into action. As soon as the brake-pipe is recharged with compressed air, the triple valve lifts and cuts off the reservoir from the cylinder, thus releasing the pressure from the back of the piston, which is brought home by a helical spring so as to release the blocks from the wheels.

The Westinghouse brake is used among others by the Caledonian, the Great Eastern, the Great North of Scotland, the London, Tilbury, & Southend, the North British, the North Eastern and the Chatham section of the South-Eastern & Chatham, but owing to the running of through carriages and trucks, etc., many of their engines, like some

of those of the Brighton, are fitted with two brakes, the other of which is the Automatic Vacuum This is the brake used on the Great Central, the Great Northern, the Great Western, the London & North Western, the London & South Western, the Midland, and indeed most of the other lines

This works on the opposite principle, though it is not quite true that no pump is used, for a few of the companies work a pump off the cross-heads of the engine for maintaining the vacuum while running Anyhow, under every carriage is a cylinder and reservoir and a train-pipe coupled up from carriage to carriage to the reservoir on the engine At the bottom of the cylinder is a valve in which there is a small brass ball working horizontally, and therefore with practically no friction, which closes the entrance to the vacuum chamber but allows the outside air to enter beneath the piston The air is not compressed, but exhausted by means of an injector on the engine, the working pressure of the vacuum thus caused being 20 in below that of the atmosphere So long as the vacuum is maintained the brakes are off, but as soon as air is admitted, intentionally or unintentionally, the vacuum in the top of the brake-cylinder is affected, the ball-valve acts, and the pressure of the outside air in the bottom of the cylinder forces up the piston which works the lever and pull-rods and brings the brake-blocks into action on the wheels To release the brake, the driver works the injector until the vacuum in the pipe is equal to that in the reservoir and above the piston, when the valve between the reservoir and pipe opens of itself and piston and lever fall by their own weight, assisted by spiral springs The piston has an area of 314 sq in, which means that a 20-in vacuum exerts a pressure of 10 lb per square inch, or a pull of nearly a ton and a half on the brake-rods, when brought fully into action, but this can be adjusted to anything less at the will of the driver or guard, just as the Westinghouse can be manipulated

It all depends on the operator, and, as most of us are aware, the examples of "the brake and how to use it" vary considerably.

Brakes have been many and strange. At one time the guard rode outside on an unprotected seat at the back of the carriage, and applied the brake by turning on a hand screw, the dust, smoke, steam, and smother through which he went making his position anything but desirable. Then he was placed inside the carriage, and had a different sort of brake on almost every line. Then it began to be recognised that the brake should not be confined to one or two vans or carriages, but should be applied to all, in fact should be continuous; and in 1873 there was a series of trials of continuous brakes at Newark in which various systems were experimented with, some mechanical, some hydraulic, some pneumatic. The conditions, however, were so ill-provided for that the results were unconvincing, and each of the patentees went away from the refreshment tent at Rolleston Junction self-satisfied that his own system was the best. The Midland sent three trains, two with hydraulic brakes and one with the Westinghouse, which they had brought over with the Pullman cars; and the Brighton train was also fitted with the Westinghouse, which the company has retained ever since, although the Midland has abandoned it for the Automatic Vacuum. For years the North Western persisted with Clarke & Webb's, by which the momentum of the train was utilised as the power, but at length this was replaced by the Simple Vacuum and then by the Automatic Vacuum, with discouraging results, for soon after it was introduced a North Western train so fitted ran through Carlisle station into a Midland engine, the brake failing owing to an accumulation of ice in the droop of the brake-pipe!

The battle of the brakes was almost as strenuous as that of the gauges, but things have now settled down

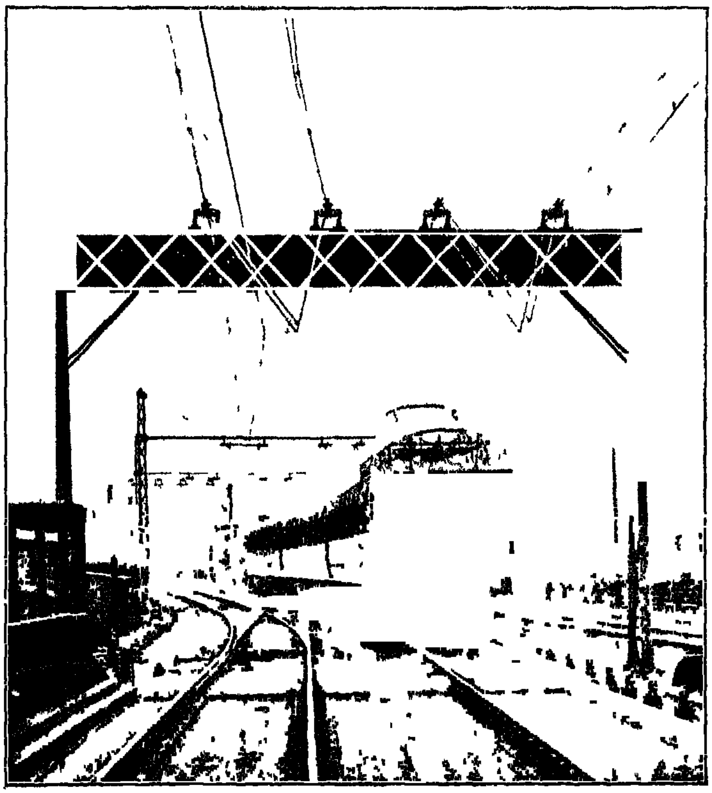
into quietude with the two we have described sharing the country between them What the state of affairs used to be may be gathered from the fact that in 1884 the Royal train was fitted with three systems of brakes to ensure its safety on the different lines on which it ran to the north

Besides the brake-pump at the side every Brighton engine has, in the cab, a speed indicator, the glass tube with the brass scale behind it that shows by the height of the water the rate the engine is running And in the cab, and more noticeable, is the name of the driver painted up with a record of the number of miles run, some of the mileages looking rather astronomical in their amount For here the good old custom still prevails of every driver having his own engine, as if it were his own horse, to look after, and be responsible for its fitness and appearance, the practice always having had the result of keeping the engines well up to the mark, and in as good, or better, trim than any, notwithstanding the hot-water tank business, for which allowances have to be made

Under the carriages there is another kind of cylinder which must not be mistaken for that of the brake apparatus This is the holder for the oil-gas by which the carriage is lighted The gas is made from petroleum in a succession of retorts at high temperatures, and scrubbed and purified much as if made from coals It is stored in reservoirs, which we see carried about on the line by the trainload, two on each truck, and it is pumped into a receiver, from which it is led in pipes to the standards from which, through flexible tubes, it is passed into the cylinders beneath the carriages at a much higher pressure than that of the compressed air in the brake cylinder, the pressure being reduced to lighting strength by the regulator in the burner

When the Board of Trade required carriages to be lighted as they passed through tunnels, the system first adopted was to stop the train at the nearest station to

the tunnel and hang an oil-lamp on to the carriage door on the left, taking off the lamp at the station beyond the tunnel. Then the lamp came to be hung through a hole in the roof of the carriage, and taken in and out in a



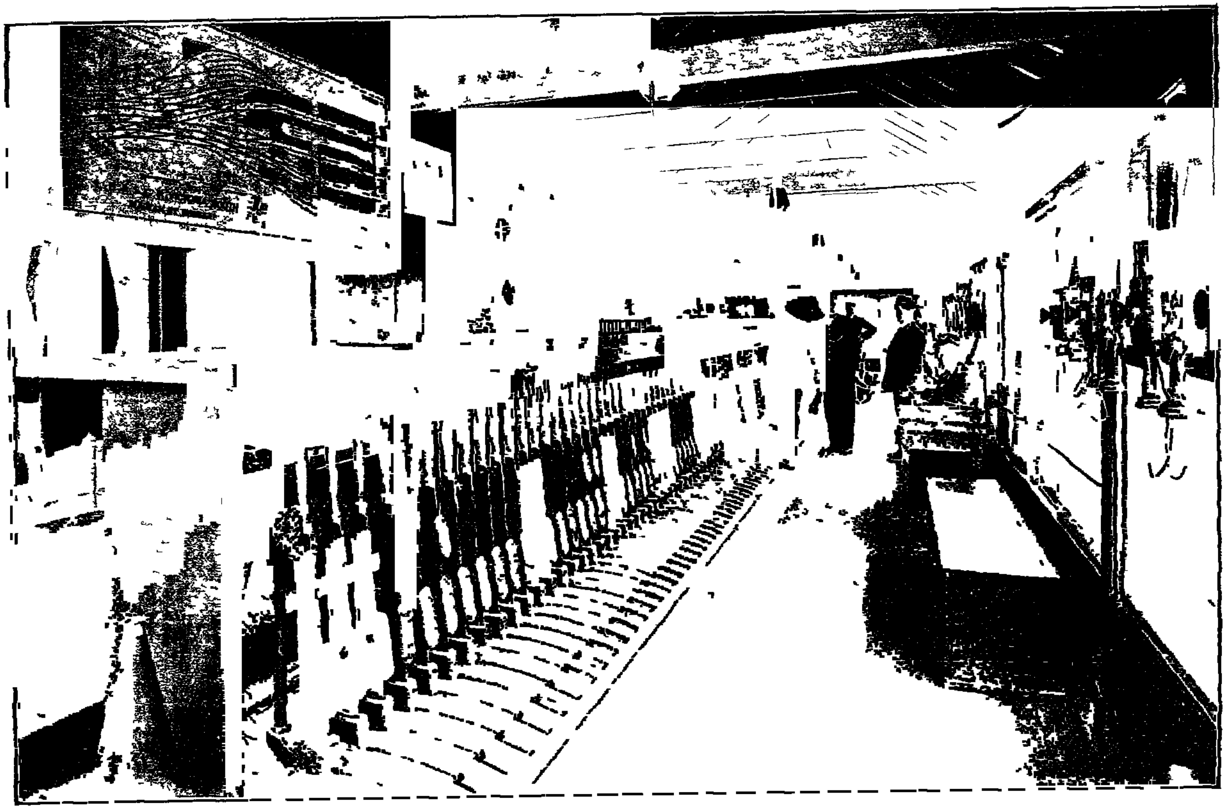
The Elevated Electric—London Bridge & Victoria

similar way, until it was found that the cost of the oil burnt was less than that of the labour, and the lamps were left in for longer distances. The smell of the old oil-lamp was not so pungent as that of oil-gas when it escapes while the cylinders are being filled, but it remained much

longer with the traveller, and in many cases was more noticeable than the light That it would be improved upon was inevitable, and there were many inventions, not only with a view to giving better illumination, but mainly to doing away with much handling of lamps

Among these was lighting by electricity, first adopted by the Brighton line Its great advantage to the company is that it pays by not being used, that is to say it can be switched on or off as required, instead of being burnt all the time like oil or gas, though there is a new pressure system for gas by which the consumption can be reduced to that of only the pilot light if desired In working the electric light a dynamo is run, not on the engine, as in America, but from the axle of the guard's van, and this charges an accumulator from which the current is supplied to the lamps, the control being in the hands of the guard, and the cables form another loop between the carriages The drawback to any system of continuous lighting is the making up and breaking up of trains to suit the varying traffic, but this has been much reduced by the introduction of the system of set-trains, that is trains treated as units, being made up of a certain number of carriages that are never changed about The brake arrangements had much to do with this, and the lighting arrangements have further encouraged it Set-trains, however, are not always possible, as an instance take the Sunny South Special, that runs to and from Lancashire and Eastbourne with any number of through carriages for distribution on the road The Brighton company were the first, or among the first, to run set-trains and to dispense with the buffers in pairs, their South London and other suburban trains being made up of carriages screwed together against a central block

From the set-train to the motor-coach is an easy step, and many of the small shuttle trains on the short branches have been replaced by the more compact contrivance



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THE SOUTH SIGNAL BOX AT VICTORIA

The service between West Croydon and Banstead, for instance, is by motor-coach, so are the services between Brighton and Kemp Town, and to West Worthing and to the Dyke, so is that between Havant and Hayling Island, Southsea from Fratton is reached by steam-motor in conjunction with the South Western, and there is even a motor-coach between Chichester and Portsmouth

The Brighton was the first railway company to run into Portsmouth, the old South Western way being to Gosport and across the harbour by ferry In 1848 the South Western opened a new route by way of Fareham to Cosham and, coming round by the north, obtained access over the Brighton metals across Port Creek and through the rampart All went well until the Portsmouth Direct project ended in a proposal to have another way in, which pleased nobody and really forced the South Western to take over the line, a proceeding which led to the battle of Havant and caused ill-feeling between the companies for some years Peace came at last, and when, in 1857, the Brighton proposed to have a West End terminus in London, the South Western directors were so friendly that they endeavoured to bring about an arrangement that "would have tended to strengthen the bond of union between the two companies" by affording the Brighton accommodation at Waterloo! Fortunately for both companies the Brighton preferred to go to Pimlico, and the bond of union was afterwards found by extending the joint line from Havant Junction to Portsmouth Town on to Portsmouth Harbour Having shared the line they shared the boats, and divided the Isle of Wight business between them, but this had happened before the opening of the harbour station, when the way to the island was from the town by tram to Southsea pier, with the luggage going astray on the way

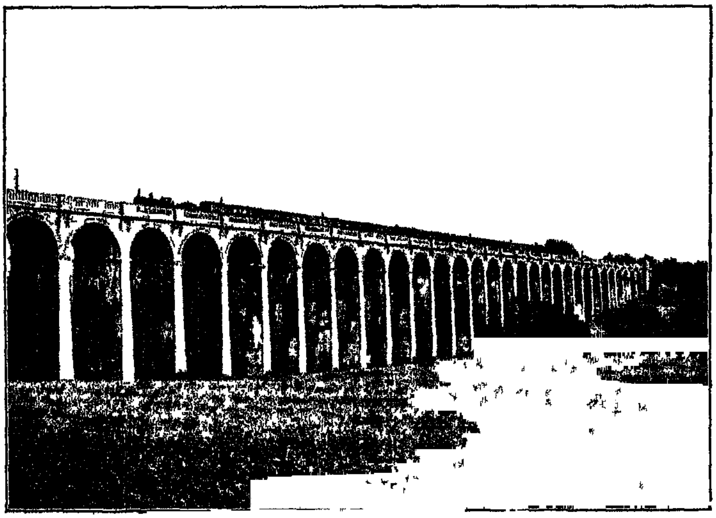
Of the Brighton company's twenty terminal stations the next largest to Victoria is Brighton, where the loco-

motive and carriage works are, the wagon works being at Lancing London Bridge covers eight acres, a quarter of an acre less, and is the headquarters of the line It is an old station, or rather the representative of an old station, for it was the terminus of the London & Croydon,

Electric Signals at Victoria

the shed which was the first terminus of the London & Greenwich, where the band played the passengers in during December 1838, having been on the Tooley Street side. Enlarged in 1850, and rebuilt fourteen years afterwards, it is conveniently arranged for those who know it, and will be more convenient still when the indicator arrives.

The business it does in the morning is enormous, and the busy time lasts longer than at most stations owing to the numbers of long-distance season ticket-holders for whom the company caters so liberally When you can travel first class all over the Brighton system for £60 a year, it suits the man of means who is not wanted until eleven o'clock to live in the country



Rastrick's Viaduct across the Valley of the Ouse

The nearest important junction is Croydon, where the City and West End lines meet, and the North Western and Great Eastern and East London trains run in with the passengers for the Continent from the north of the Thames, but the largest is Lewes, where six lines meet and the route to Paris goes off to the coast

Newhaven is a town made by the wind, for the big storm of 1570 turned away the River Ouse from its old outlet at Seaford into its present mouth under Burrow Head It is the nearest Channel port to London, being only fifty-seven miles from "The Bridge" The harbour with its two fine piers

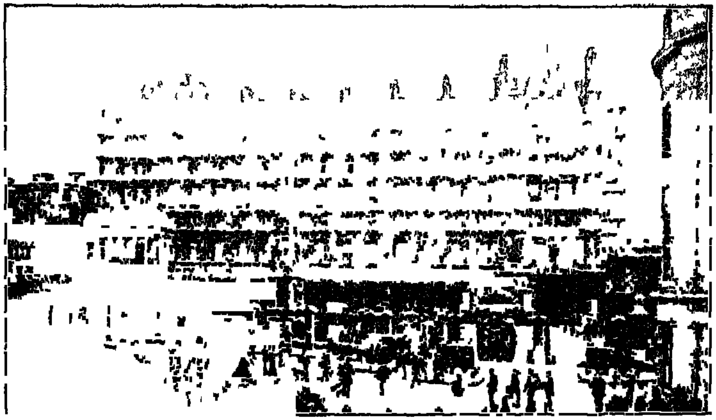
and concrete breakwater, made on the wholesale principle by which some twenty truckloads of shingle and sand were mixed at a time with 120 sacks of cement and dropped into the water, is accessible at all states of the tide, and yearly becomes busier, for the amount of French merchandise that comes to it through Dieppe and Caen seems to be endowed with the valuable quality of perpetual growth

The harbour, though the property of a separate company, is the chief port of the line, the headquarters of its maritime interests, from which the excellent steamers, owned jointly by the Brighton company and the French State Railways, take you across the Channel at over twenty knots, the two turbines, *Dieppe* and *Brighton*, travelling at twenty-two or over, and start you through that delightful stretch of French scenery that seems but a bit of Dorking and Shere, and thereabouts, on the other side

Newhaven—Getting ready to start for Dieppe

THE SOUTH EASTERN & CHATHAM

COAT-OF-ARMS



Charing Cross, with Station and Hotel

THE SOUTH EASTERN & CHATHAM

THE South Eastern & Chatham claims the county of Kent for its own, and extends for a short distance into Sussex and all through Surrey into Berkshire Beginning as the Dover Railway to afford a route between London and the Continent, it is the chief road that way still, and of its 654 miles of track the 76 to Dover are those to which it gives its best attention From Dover go the Calais and Ostend boats, and it has two other mail-ports, Queenborough for Flushing, and Folkestone for Boulogne

All down the south side of the Thames from London Bridge to Port Victoria every town and village is served by the South Eastern & Chatham, and so it is all the way round from Sheerness to Hastings Quite a number of seaside places besides those mentioned are in its territory—Whitstable, Herne Bay, Birchington, Westgate, Margate, Broadstairs, Ramsgate, Sandwich, Deal, Walmer, Sandgate, Hythe, Littlestone, Rye, and St Leonards From Hastings to Tonbridge and from Redhill to London is its

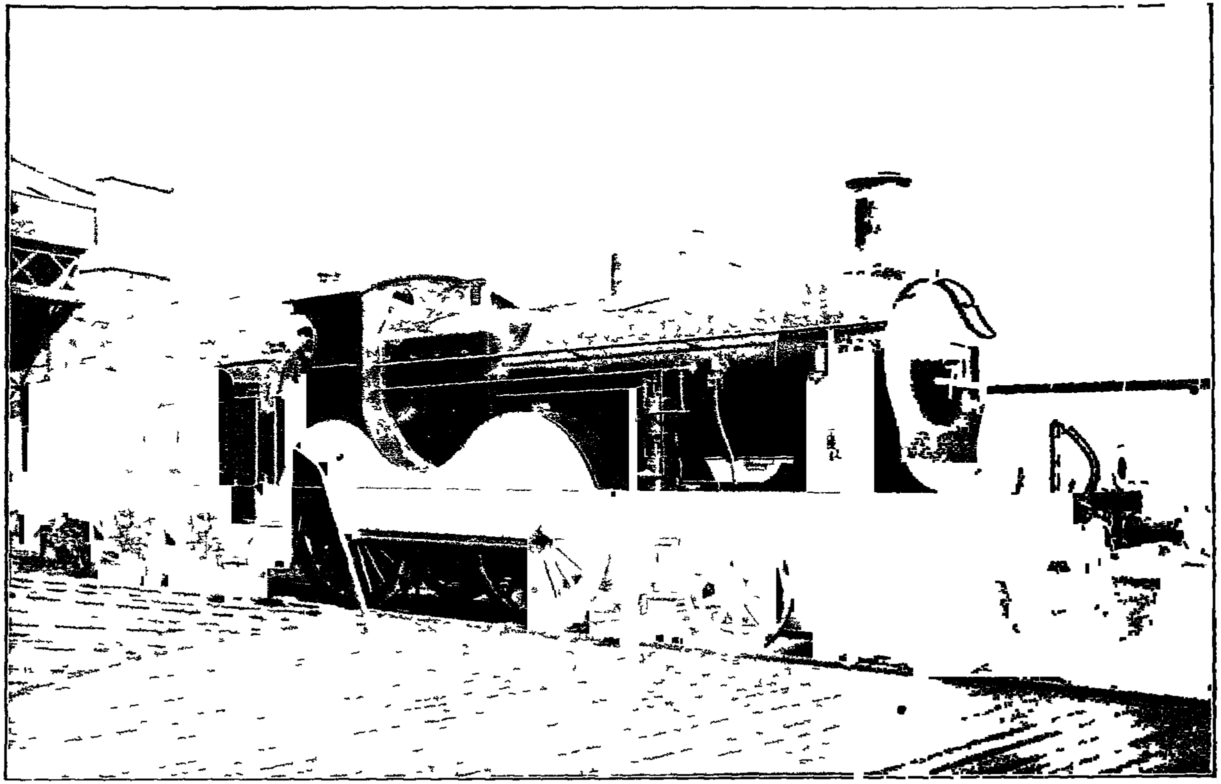
western boundary, with the spurs to Bexhill, to Reading, and to Tattenham Corner And northward of the Thames it extends into Cannon Street, St Paul's, Holborn Viaduct, Charing Cross, and Victoria

If the age of a railway be that of its oldest branch, the South Eastern is older than the North Western—as usually understood—for the Liverpool & Manchester was opened four months after the Canterbury & Whitstable, the story of which is not uninteresting and has quite a character of its own

In the early days of the last century Canterbury wanted a port, the old cathedral city seeming to be doomed to no other means of communication with the rest of the world than coach and wagon, and prices were rising alarmingly Its old port of Fordwich had become silted up, though not so much so as to-day when it remains as a pleasant little village with a church sporting the Cinque Port ship as a weather-vane—to show it is a "member" of Sandwich—and a quaint little town hall and accessories that claim a paragraph in every guide-book

Thus it came about that in 1822 the citizens resolved on improving the river Stour and making it navigable from Sandwich, as it used to be, and, after much talk and a little surveying, they introduced a Bill into Parliament in the 1824 session which was opposed by the Commissioners of Sewers on the ground of inadequate surveys and evident under-estimates, and promptly rejected. Nothing daunted, the Canterbury people increased the proposed capital, and brought in a Bill next year which met with a better reception and duly passed

The way seemed clear for the Stour improvement, but while the discussion was in progress in 1823, there happened to be in Canterbury no less a person than William James, the promoter of "engine railroads," as he called them, the friend and partner for a time of George Stephenson, whose department so far as the partnership was concerned



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NO 273 GOING ON TO THE TURNTABLE AT CANNON STREET

was "to give his best assistance for the using and employing the locomotive engines" on railways south of an imaginary line drawn from Hull to Liverpool

James, according to Robert Stephenson, was the original projector of the Liverpool & Manchester There may be some doubt about this, there is none about his promotion of the Canterbury & Whitstable He did his best for the partnership He wrote and spoke and agitated generally to such effect that he got together a rail party in the city to oppose the river party, which obtained so much support that in 1824 he was sufficiently advanced to apply to George Stephenson for him to send down a surveyor, and Stephenson sent him John Dixon of Chat Moss fame

Dixon was a practical engineer who knew what he was about, and had very soon been over the half-dozen miles or so of the way to Whitstable and chosen an easy, suitable route through Blean The Canterbury committee were called together to discuss his plans And then a hitch occurred "What! No tunnel?" asked one of these intelligent men "No, sir," said Dixon, "I am pleased to say no tunnelling is necessary, and the line is practically level" "Oh," said some of the others, "no tunnel! We must have a tunnel"

The thing is almost incredible, but it is the fact The Canterbury people insisted on having a tunnel, Dixon's plans were rejected, and Stephenson was asked to journey to Canterbury in person and plan out a route with a nice tunnel in it Needless to say there was no difficulty, the site for a tunnel was found at Tyler Hill, and to reach it and get through to Whitstable the road lay through a strip of country undulating enough and picturesque enough to please any one who did not mind paying for it, and it contained everything no complete railroad should be without

It started from North Lane at a gradient of 1 in 41, and went at 1 in 56 for over 3000 yards to Tyler Hill, necessitating a pair of 25 horse-power stationary engines on the

summit to haul the trains up by an endless rope, and there was the tunnel in four different dimensions, the big end towards the city, whose people were so proud of it that they shut it up at night by gates, the riders for which can still be seen at the entrance, then there was a gentle gradient of 1 in 750 to Clowes Wood, where were two more stationary engines at the top of gradients of 1 in 28 and 1 in 31 to Bogshole, then came a mile of level, and then another down-grade where another stationary engine was soon put, and then a dapper little bridge, still standing, over Church Street, and then a level run to get up speed on in the finish to the harbour There was everything the committee asked for, and if anything else was required it could be supplied, but the additions would be extra What Stephenson and James thought of it all is not recorded, but the deposit money was forthcoming, the Bill was lodged, and it was discussed and passed in the same year as the river Act, and Canterbury had to choose which it would go ahead with, the rail or the river? The rail won, and Fordwich was left to sleep

The line was made by navvies sent down from the north—Joseph Locke being for a time resident engineer—and on the 3rd of May 1830 it was opened with much ringing of bells and waving of flags Twenty carriages—that is, open trucks—in two divisions, worked by the Invicta, the company's only engine, started for the oyster town to brave at the beginning the terrors of the first tunnel ever entered by train But really we must rely on the local newspaper—"The entrance into the Tunnel was very impressive, the total darkness, the accelerated speed, the rumbling of the cars, the loud cheering of the whole party echoing through the vault, combined to form a situation almost terrific, certainly novel and striking"

There was never a dividend The line was always worked at a loss, but it never stopped working until it was relaid on being leased by the South Eastern in 1844 Some

time after it opened it was leased to contractors who worked it with horses and tried to sell its only engine, but, there being no other rails for it to run on nearer than Greenwich, there were no buyers, and it was left to be taken over with the rest of the plant by the South Eastern people, who took

The Buffet Car of the Continental Express

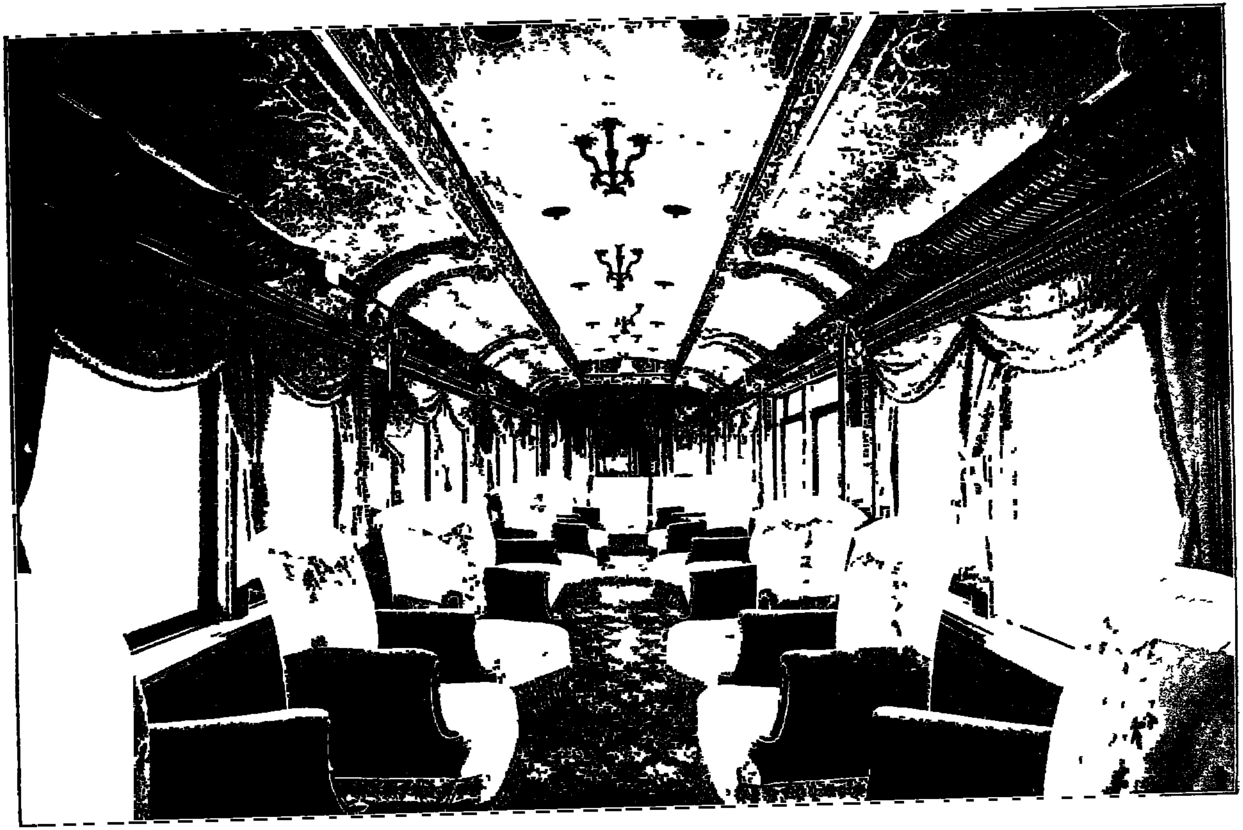
up the old 15 ft Birkinshaw rails, 28 lb to the yard, with their oak sleepers a yard apart and the sheaves a fathom apart on which the ropes ran The old signals were also taken away—the drums that were hoisted on the engine-house chimneys, and the shutters hung by the middle, that meant danger when vertical and safety when horizontal

The Invicta was at Ashford for years, now she is in the Dane John gardens at Canterbury, but not in her original state As built by the Stephensons—and she was their twentieth engine, the Rocket being their nineteenth—she had 4-coupled wheels, 4 ft across, driven by two outside cylinders at the forward end, the first instance of that arrangement on record These were 10 in with an 18-in stroke, and the boiler had twenty-five 3-in tubes—not a

10-in flue as now—her total heating surface being 192 sq. ft, her working pressure 40 lb, and her weight $6\frac{1}{4}$ tons She is not the only relic of the old times, for there still exists the Duke of Wellington's carriage of 1838 which he used while at Walmer, his route to London being by road to Canterbury, by rail to Whitstable, and thence by boat A photograph of this old first and second composite (S E R No 211) is at South Kensington There is a popular notion, helped by certain apocryphal stories, that the Duke was an opponent of railways, whereas he was one of the first of leading men to appreciate their importance.

The £50 shares of the old company were at ten shillings before the news got about that the South Eastern were going to take over the line, and then they went up to £30, but the South Eastern did not buy the line until 1853, from 1844 until then they only leased it The famous tunnel there was so much fuss about was rather small at the Whitstable end, and it was not enlarged, so the antiquity of the present carriages must be excused They are only little ones

The next link of the South Eastern chain was the Greenwich line, the first of London's railways It was the first overhead railway, and its engineer was George Thomas Landmann, once a colonel of Royal Engineers, who after many adventures had taken to railway work It ran from Joiner Street, Southwark, 1144 yards from the Royal Exchange, to Greenwich, $3\frac{3}{4}$ miles, the turnpike road being $5\frac{1}{2}$ miles, and it was on brick arches all the way, 878 of them, except for an iron bridge over Bermondsey Street and a lifting bridge over Ravensbourne Creek The arches were adopted because much of the route lay below Thames high-water mark, and it was hoped that a large revenue might be derived from letting them as houses and shops, and some were so let, it being so convenient to have a really weather-proof dwelling with an intermittent rumble on the roof. From Spa



DRAWING ROOM CAR OF THE HASTINGS EXPRESS

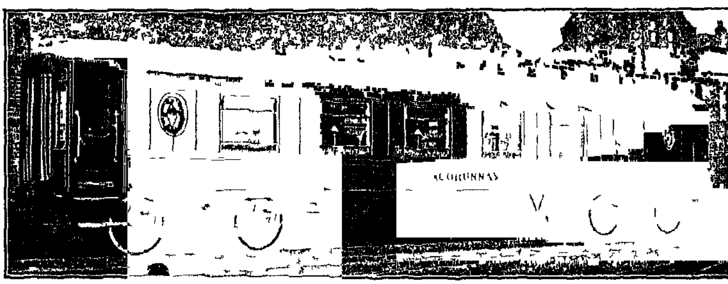
Road to Deptford there was a footpath in front of the arches, for the use of which a toll of a penny was levied, which it was expected would bring in an appreciable amount as the path was a short-cut from the existing road

The contractor was Hugh M'Intosh, and his undertaking was not so profitable as he anticipated owing to his having in places to go down 24 ft to get a firm foundation for the arches, but he did his work well, as can be seen in the monotonous viaduct which is still as level as when he made it The rails, a double line of them, were fastened into the chairs by malleable iron wedges, the chairs being fixed to rough blocks of granite, or Bramley Fall stone, of about four cubic feet each, but between the chair and the stone Landmann put a thin piece of elm plank, thus beginning the return to the old wooden sleeper

The site of the terminus is included within the present London Bridge Station It was approached by a sloping carriage road and a paved footpath, and entered through handsome iron gates As originally laid out it was 60 ft wide by 400 ft long, with four lines of rails converging to two at 130 yards from the entrance, but the first building seems to have been a shed The line was opened to Deptford on the 14th of December 1836, and in the first year there were 1,462,591 passengers who paid—notice the delicate insinuation—the train tickets being copper checks In December 1838 it was opened to Greenwich To attract passengers, and make things holiday-like, there were bands of music just as the steamboats had, and most bitter opponents were the steamboat people and all the river fraternity, who foresaw that the railway meant hard times for them, as indeed it did, for steamboats and wherries cannot struggle successfully against railways and tramways plying between the same places, as the London County Council have in recent years found

to their sorrow The London & Greenwich was a great work, and much was thought of it at the time, but it is not the only line on arches belonging to the South Eastern & Chatham, for the Metropolitan Extension runs on arches, 742 of them, and 94 girder bridges, and it is two miles longer

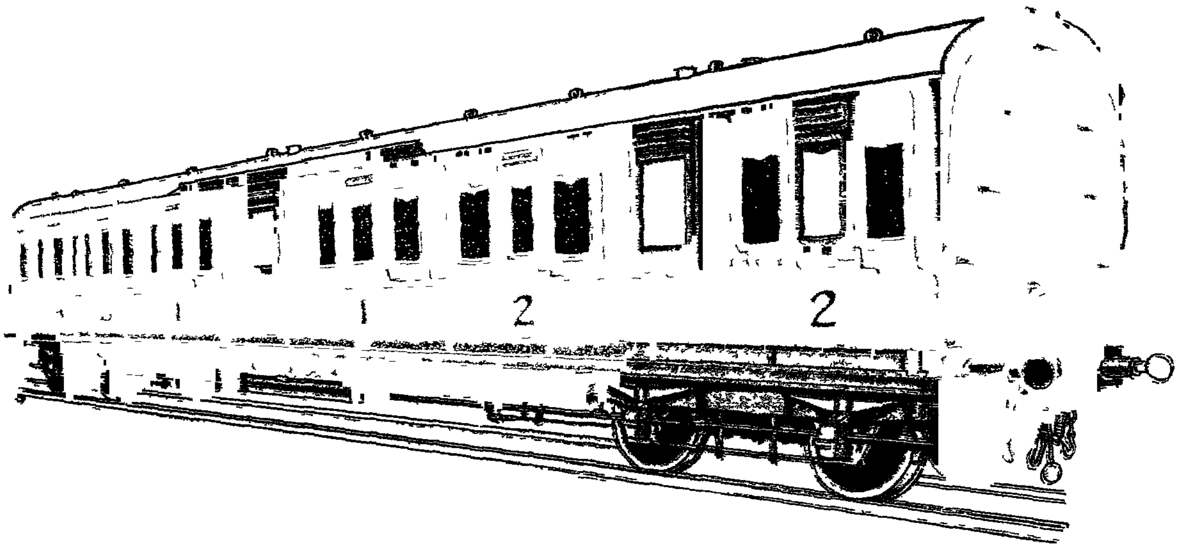
We must now go back a little In 1825 a railway was being talked about from Manchester to Liverpool, why should there not be one from London to Dover? And what better route could there be than from London along the Thames valley to Gravesend and then on, or



The new Pullman Car "Corunna"

even from Gravesend to Dover, thus avoiding the voyage round the Forelands? So a line was projected—and it met with such opposition from every vested interest on the road that nothing could be done Seven years afterwards the project came to the front again, and again had to be postponed Next year, however, 1833, the London & Greenwich obtained its Act, and this put heart into another group of projectors who proposed a line through Maidstone without success, and in 1835, when the London & Croydon Act passed, there was quite a lively contest between the Maidstone scheme and the Gravesend scheme that prevented either making way

Next year, while the numerous companies anxious to go to Brighton were in full endeavour, a third scheme was introduced—to start a line from Redhill to Dover



THE SOUTH EASTERN & CHATHAM RAILWAY

Composite Carriage No 3804

Extreme length	51′	Extreme width	8′ 0¾″	Electric lighting	Steam heated
Seating capacity	First class	10		Lavatory accommodation	
	Second ,,	14		Vacuum brake	
	Third ,,	16		Electric passenger communication	

through the level country of the Weald, taking Tonbridge, Ashford, and Folkestone on the way The Act for this was obtained, but next year came the report of the Parliamentary referee on the Brighton projects, and the passage of the Brighton Company's Act with the curious restrictions on the approach to London inserted in the interest of the London & Croydon and the London & Greenwich For a time the South Eastern doubted if it were worth while to go on, particularly as they had the offer of another and better route

This was the Central Kent, one of the lines projected by Sir John Rennie The Central Kent was to run from London Bridge to Sandwich by way of Lewisham, Eltham, the Crays, the Darent, Gravesend, crossing the Medway a mile above Rochester, thence within a mile of Maidstone to Eastwell, where it sent off a branch to Ashford, Folkestone, and Dover, while the main line went on through Canterbury to Sandwich Up the valley of the Darent there was to be a branch to Sevenoaks and Tonbridge, and thus nearly every important town in Kent was provided for, and the route to Dover was fourteen miles shorter than that for which the Act had been obtained, and its steepest gradient was 1 in 264 This would undoubtedly have been the best line, and the South Eastern people would have substituted it for theirs had it not been for the opposition of Lord Winchelsea and the people of Maidstone, who would not hear of any railway coming near their town, which they considered to be amply provided for by the barges on the Medway And so the project fell through

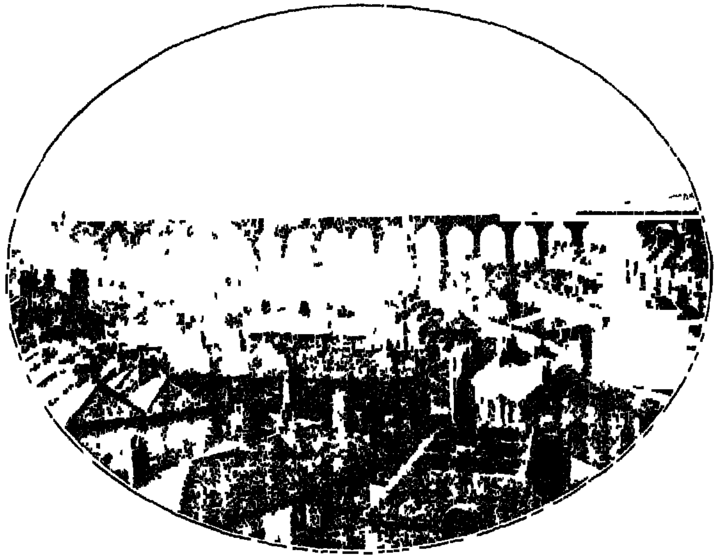
Thus it came about that under the Act of 1837 the Brighton Company made the line from Redstone Hill (Redhill) to Jolly Sailor (Norwood Junction) on the London & Croydon, the South Eastern paying £340,000, half the cost with interest of the twelve-mile stretch, and becoming the owners of the southern half up to Coulsdon, and when the line opened their trains ran on their own metals

from Redhill to Coulsdon, on Brighton metals from Coulsdon to Norwood Junction, on Croydon metals from there to Corbett's Lane, and on Greenwich metals from there to London Bridge Thus were the Brighton and South Eastern in their infancy nurtured by Parliament in unpunctuality, for on such a road it was absolutely impossible to work even a moderate traffic and keep time To complete the story it should be said that a station was placed at Paddock Wood, then called Maidstone Road, which was twelve miles from Maidstone, and soon after it was opened the people of Maidstone, who had wrecked the Central Kent and stopped the best road to Dover, came to the directors of the South Eastern with a petition humbly beseeching them to provide a branch, which branch was opened in 1844

The engineer of the South Eastern was Sir William Cubitt, who invented the treadmill and did many other things besides making canals, harbours, and railways In his evidence before the Gauge Commission he said, "With a perfect railway I do not know any speed that could be dangerous to the public safety in a straight line", and he laid out the South Eastern for speed with a perfectly straight run of forty-eight miles from just round Redhill to Ashford, and he made it practically level throughout that distance Beyond Ashford he had more scope for his engineering powers He crossed Folkestone gap by the viaduct over the river Foord of 19 arches over 100 ft high, and beyond Folkestone he made the splendid stretch through the chalk and along the shore with its four tunnels, Martello 530 yards long, Abbot's Cliff 1933 yards long, and the two through Shakspeare's Cliff 1392 yards long, while between the tunnels, although the sea occasionally breaks over it in the winter, he laid the line 20 ft above high-water mark, and beyond the Shakspeare ran it over the open timber bridge under which the sea washes at very high tides

These tunnels through the chalk were made by driving

in horizontal galleries from the sea-face instead of making vertical shafts from the top in the usual way, but the most famous piece of work was the blowing away of the face of Round Down Cliff, on the 26th of January 1843, with 18,000 lb of gunpowder fired by electricity The story of this successful introduction of electrical firing as it ap-



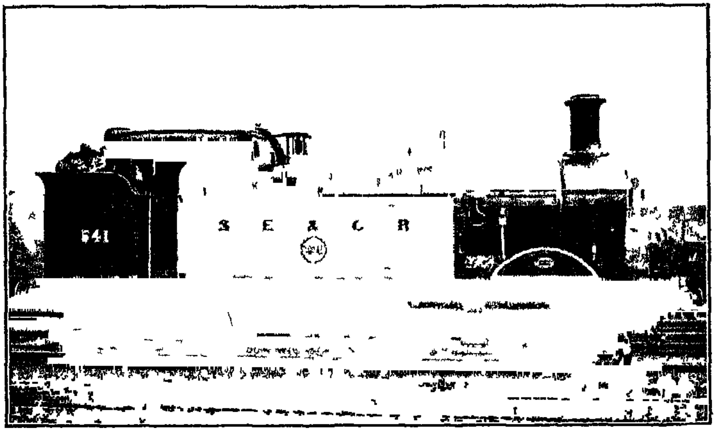
The Foord Viaduct at Folkestone

peared in *Our Iron Roads* is too well told to be spoilt by paraphrasing, and here it is —

"At the time appointed for the blasting, a number of distinguished visitors reached the Downs, and joined the directors and the scientific corps at a commodious pavilion erected near the edge of the cliff, at a distance of about a quarter of a mile from the point of explosion When the arrangements were completed and the spectators assembled, curiosity was at its height, and the most strange and fearful speculations were entertained by the people assembled as to the possible contingencies which might

arise 'What,' said Professor Sedgwick—'what if there should be a concealed fissure—a blinded chasm—in the cliff behind us? A smart vibration might throw it open' 'What then?' inquired a ghastly querist 'We shall be swallowed up!' muttered one in response, while another sighed, 'We shall be swallowed down!' Still the fascination was irresistible, and though many were uneasy, and wished to be gone, no one withdrew After a long suspense of half an hour the discharge of half a dozen blasts on the face of Abbot's Cliff occasioned a great sensation When two o'clock arrived, the time appointed for the explosion, the interest which pervaded the multitude became most intense The choughs and crows that winged the midway air were distinctly heard amid the profound calm that prevailed The signal which announced it to be fifteen minutes before firing having been given, all the other flags were hoisted The air was still, the sea was calm, and the murmuring surges gently laved the cliff's huge base A quarter of an hour now passed and a shell with a lighted fuse was thrown over the cliff, from which it bounded to the beach, where it burst with an astounding report, followed by echoes from the hills, which had the effect of sharp fusilades of musketry The flags were then hauled down and at length the one minute before firing arrived The excitement of the people was now painfully intense, while their courage was put to the severest test 'Now! Now!' shouted the eager multitude, and a dull, muffled, booming sound was heard, accompanied for a moment by a heavy jolting movement of the earth, which caused the knees to smite The wires had been fired In an instant the bottom of the cliff appeared to dissolve, and to form by its melting elements a hurried sea-borne stream The superincumbent mass to the extent of about five hundred feet was then observed to separate from the mainland and as the dissolution of its base was accomplished it gradually sank to the beach. In two minutes its dis-

persion was complete The huge volleys of ejected chalk, as they swelled the lava like stream, appeared to roll inwards upon themselves, crushing their integral blocks, and then to return to the surface in smaller and coalescing forms The mass seemed to ferment under the influence of an



No. 541—A typical Tank Engine for Suburban Traffic

unseen, but uncontrollable power There was no roaring explosion, no bursting out of fire, and, what is very remarkable, not a single wreath of smoke, for the mighty agent had done its work under an amount of pressure which almost matched its energies the pent-up fires were restrained in their intensity till all smoke was consumed A million tons of weight and a million tons of cohesion held them in check When the turf at the top of the cliff was launched to the level of the beach, the stream of debris extended a distance of 1200 ft, and covered a space of more than fifteen acres! The moment the headlong course of the chalk had ceased, and the hopes of the spectators were realised, a simultaneous cry arose of 'Three cheers for the engineer!' and William Cubitt was honoured with a hearty huzza from the lips of a grateful

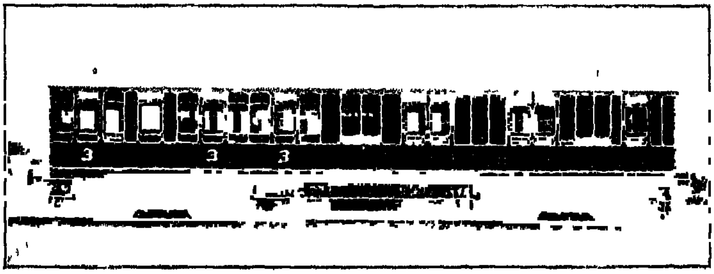
people An era in the history of engineering had passed"

The best-known tunnel on the line is, however, not in the chalk, but in the Weald Clay at Bletchingley, through a spur of Tilburstow Hill Here the resident engineer was F W Simms, who carefully recorded in detail every step in its construction and took it as the example for his

New Drawing Room Car, Boat Trains

book on tunnelling, which is the standard work on the subject known to every engineer It is the whole story of a tunnel from its survey to its completion Bletchingley cost £72 per yard, and it measures 1324 yards , Saltwood, near Sandling Junction, to which Simms moved on as resident when he had finished it, and treated much in the same way, measures 954 yards, and cost £118 per yard, it being a much more difficult job. Here the men had to be worked in four shifts, and at one time the water was

running at a thousand gallons an hour, bringing the sand along with it in dangerous quantities, until the happy idea occurred to him of packing straw behind the poling which kept the sand back and let the filtered water through All along the engineering work was thoughtful and sound, and, as Cubitt pointed out, the line was made with a wider base than usual, for it was 30 ft wide to secure greater safety and better drainage than had up to then been



Third class Brake of Continental Express

attained "A railroad," says Robert Hunt "has three parts, substructure, superstructure, and rolling stock" The substructure is the bed the superstructure is the permanent way and with regard to these the South Eastern was the best line of its time

The Bletchingley tunnel was opened in May 1841 In May next year the first train ran through from London to Tonbridge, then called Tunbridge, where the branch to Tunbridge Wells, opened two years afterwards, had been begun In August Headcorn was reached, and in December the trains began to run through to Ashford In 1843 the line was opened to Folkestone, and the year following it reached Dover

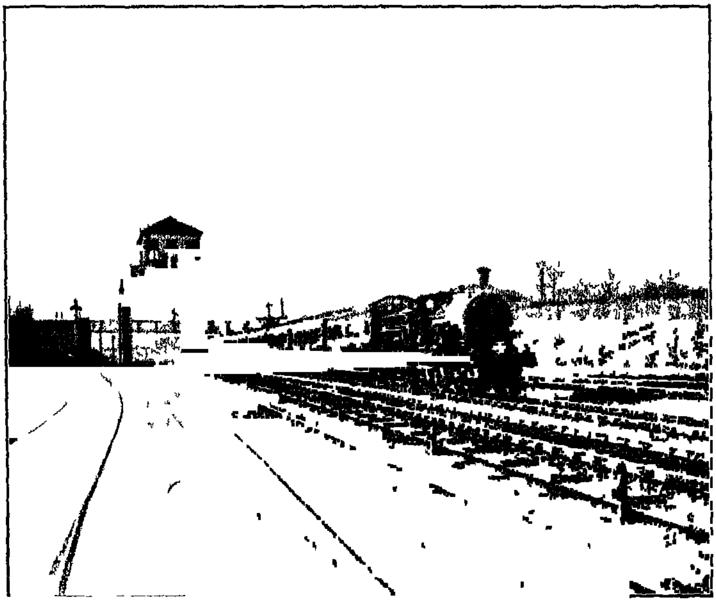
That year, 1844, was an important one for the company, for not only did they get to Dover, but they opened their first London branch, that to their new "West End Station"—which was Bricklayers Arms! Railway com-

panies are occasionally somewhat bold in their advertisement, but it may be doubted if any of them in these days would venture so to describe Bricklayers Arms, which is in the Old Kent Road Passenger trains were worked into it as a terminus until the end of January 1852, and then it began its career in the goods business only, broken by one bright interval for which it is not likely to be forgotten When H R H Princess Alexandra of Denmark arrived at Gravesend on the 3rd of March 1863, the special train was run into Bricklayers Arms Station There London received the future Queen of England on the way to the wedding at Windsor, and after this blaze of glory it settled down to its position as the chief goods depôt of the line

Bricklayers Arms is notable in railway story for the step forward there taken in signalling When it was opened, Charles Gregory, who introduced the semaphore into railway practice by placing the first at New Cross, gathered the chains from all the signals into a stirrup frame, and fixed to the frame a sort of parallel motion that ran between the stirrups in such a way that the depression of any one stirrup pushed the parallel bars into a position to act as a block on the others Thus two conflicting signals could not be given at the same time This was not quite interlocking, as there was no mechanical connection between the signals and the points, but it was the first move in that direction

In 1856, when the signalling arrangements were enlarged and improved, John Saxby of Saxby & Farmer worked from the signal cabin eight semaphores and six pairs of points, all so governed and locked that it was impossible to move any signal which was contrary to the position of the points, and equally impossible to give any signal that was in conflict with another The principle was the simultaneous movement of points and signals contrived in such a way that the signals were dominated by the points

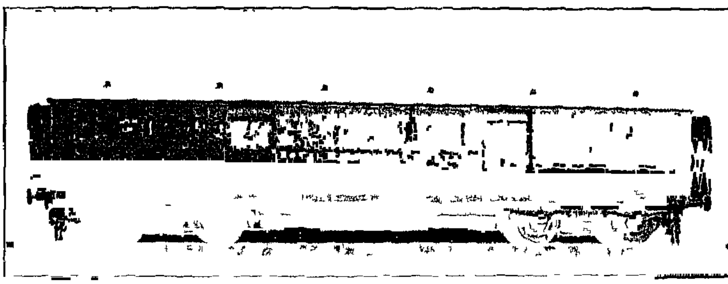
Saxby was the first to put in a row together the levers for working the points as well as those for working the signals At first he used rocking shafts, but in 1860 he replaced these by sliding bars, the principal levers being vertical and the locking levers horizontal In 1867 he intro-



The American Car Train at full speed near Orpington

duced locking by the spring catch, so that before the lever was moved the mere intention of moving it effected the locking, and a wrong signal could not be given by negligence or any strain or slackness of the apparatus, but in this device he ran a sort of dead heat with Easterbrook, who was three days in front of him with one patent and three days behind him with the next, so that for a short time no levers could be moved owing to Saxby having secured one end of them while Easterbrook had hold of the other

There was another patent for interlocking of which some mention must be made In October 1859 Kentish Town Station was ready for opening on the North London when Colonel Yolland, the Government Inspector, refused to pass it as he wanted some means of preventing the

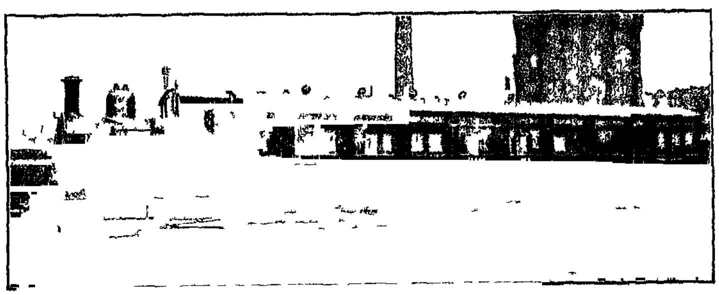


The Post Office Sorting Van

signalman from making a mistake Stevens, the contractor for the signalling work, undertook to put this right, and the opening was postponed for him to do so. In November Colonel Yolland came again to examine the new contrivance, in which the signals were so arranged that the putting down of one stirrup disengaged the other The colonel put his foot into both stirrups, and so lowered both the up main and the up branch, and he refused to pass the line He was asked to suggest some way out of the difficulty "Oh," said he, "it is not my province to suggest but to approve" But having understood what the colonel had in his mind, Austin Chambers tackled the problem, and in a month was ready for the colonel with an arrangement that was satisfactory, and the line was opened in December. The same day the General Manager gave Chambers a cheque for fifty pounds to patent the invention, and this was done; and it was immediately adopted all over the North Western

Neither of these interlocking systems can be understood without an examination of the mechanism or working a

model They have been compared to a church organ, but as has been well said of them, a performer on the organ can touch any keys he pleases in any order or in any number, he can discourse most eloquent music, or he can rend the ears of his audience by abominable discord Not so the signalman Concord he can produce at will, but discord is utterly beyond his powers He cannot open the points to one line and at the same time give a safety signal to a line which crosses it, and the points must be properly set or the signal for a train to pass cannot possibly be given Moreover, while a train is actually travelling through the points, not even the signalman can change their position or disturb them until the last vehicle has passed in safety When he gives a clear signal for a main line, he cannot open a point crossing to it, and when he gives a clear signal for a crossing he must show danger for all the lines which it crosses He can

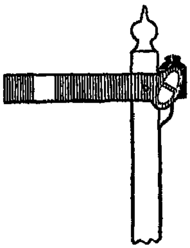


A smart little Steam Car on the Wickham & Hayes Branch

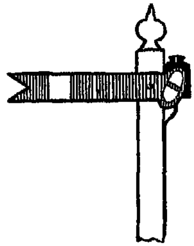
send a train on to any one line, but he has to do so in a systematic manner, and if he brings about an accident it is not by one pull of a lever but by the pull of perhaps half a dozen, all in due order and strictly according to rule, and often in these days he is stopped from doing this by the man in another box, with which his signals are also connected

The simplification of signalling is progressing apace

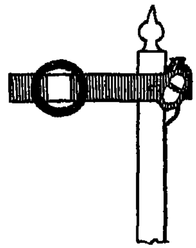
COMMON OBJECTS OF OUR HOME RAILWAYS



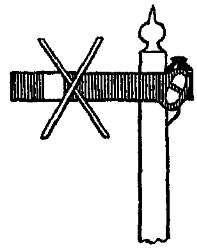
Stop Signal
Must not be passed by drivers when at danger



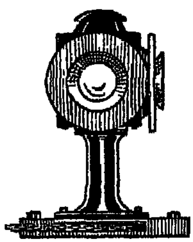
Distant Signal
May be passed with caution



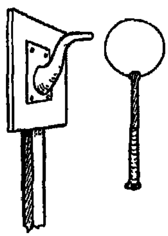
Shunting or Engine Signal



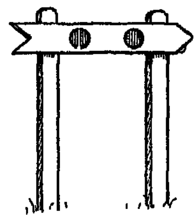
The cross bars denote "Not yet in use."



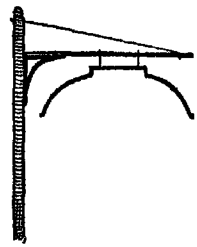
Ground Disk or Dummy.
For crossovers or roads or shunting operations



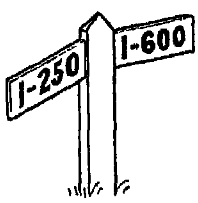
Staff and Catcher
The staff is carried by driver on single line



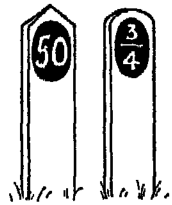
Denotes line under extensive repair in direction of arrow



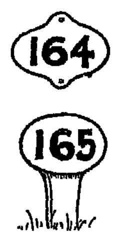
Loading Gauge
Loaded wagons passing under clear bridges and tunnels



Gradient Post
Denotes the rise or fall of the road.



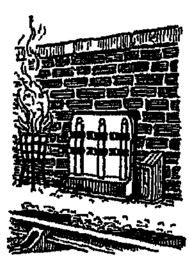
Mile Posts



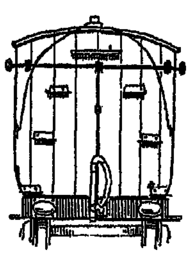
All bridges and culverts are numbered in this way

Warning to drivers when approaching a difficult junction

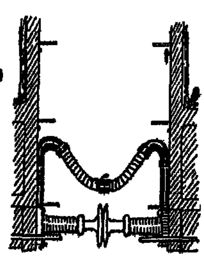
These are at the bottom of an incline for derailing a train running away in the wrong direction



Dwarf Signals
For use in fog signalling when the ordinary signals cannot be seen



Electric communication along the train. The disks denote where the alarm was given



Brake Pipe
Air-pipe connection of the vacuum brake

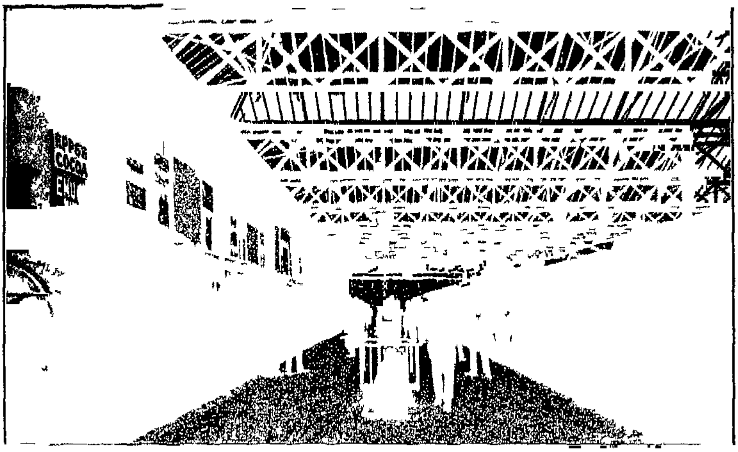
and soon it will be almost entirely automatic, and it is interesting to note that the Chatham & Dover did much to help along the reform by its early introduction of Sykes's electric block system alluded to above The telegraph block, however, goes back much earlier, for it was introduced on the Yarmouth & Norwich in the very year that Bricklayers Arms was opened with Gregory's stirrups, while signalling by electrical contacts began in a small way on the Lancaster & Preston in 1849

The block system on which our trains are now worked is not difficult to understand The line is divided into sections by signal-boxes in electrical communication with each other, and only one train is allowed to be between any two boxes on one line at a time The signalman receives a warning that a train is coming and answers it that the line is clear if that be the case He then receives the notification "Train on line," and as soon as he does so sends on the "Be ready" signal to the next box, where it is answered and sent on in the same way, so that the signals are always a section in advance of the train. In some places there is a "permissive block" by which two trains may be on the same section, but the second train is always under control

Meanwhile confusion was increasing with increase of business at "the Bridge" with four companies running into it. As a remedy they ceased to work independently after the 1st of March 1844, when a joint committee was formed Next year matters were simplified by the South Eastern taking over the London & Greenwich on a 999 years' lease at a rental of £45,000 In the following January the committee was dissolved, and in July the London & Brighton absorbed the London & Croydon and became the London, Brighton, & South Coast This left two companies in the place of four, both using the same metals from Redhill and both running in on to the arches at Corbett's Lane for the last 3036 yards into London

Bridge, and though the South Eastern soon began to find other outlets from the Greenwich line, that arrangement lasted until the Brighton opened their new line from Purley to Earlswood fifty-four years afterwards

The same year, 1846, the South Eastern continued its line north-east from Ashford to Ramsgate and Margate, taking Canterbury on the way and linking up with the Whitstable, which soon lost its importance, for Ramsgate became the cathedral city's long-desired port for all purposes that a special port could be of use with a railway



Charing Cross Station, showing new roof

to so many ports at the end of Castle Street Sandwich, Rennie's eastern terminus, was not to be left long out in the cold, but instead of being approached in the Central Kent manner direct from Canterbury, it obtained access to London by the line opened in 1847 between Minster and Deal, in which the Iron Duke, still at Walmer, took so much interest that out of compliment to him the company adopted Wellington brown as the colour of their carriages

In 1843, Morris, who had left Rennie to become one of the contractors for making the South Eastern, bought

Telford's old harbour at Folkestone for £10,000, to sell it again to the company for a considerable consideration, and thither the branch from Folkestone was opened in 1849 so as to give the company another route to France In time the railway company bought the boats that were working the passage , but they would not buy the Dover boats when they were offered to them, and thereby came trouble

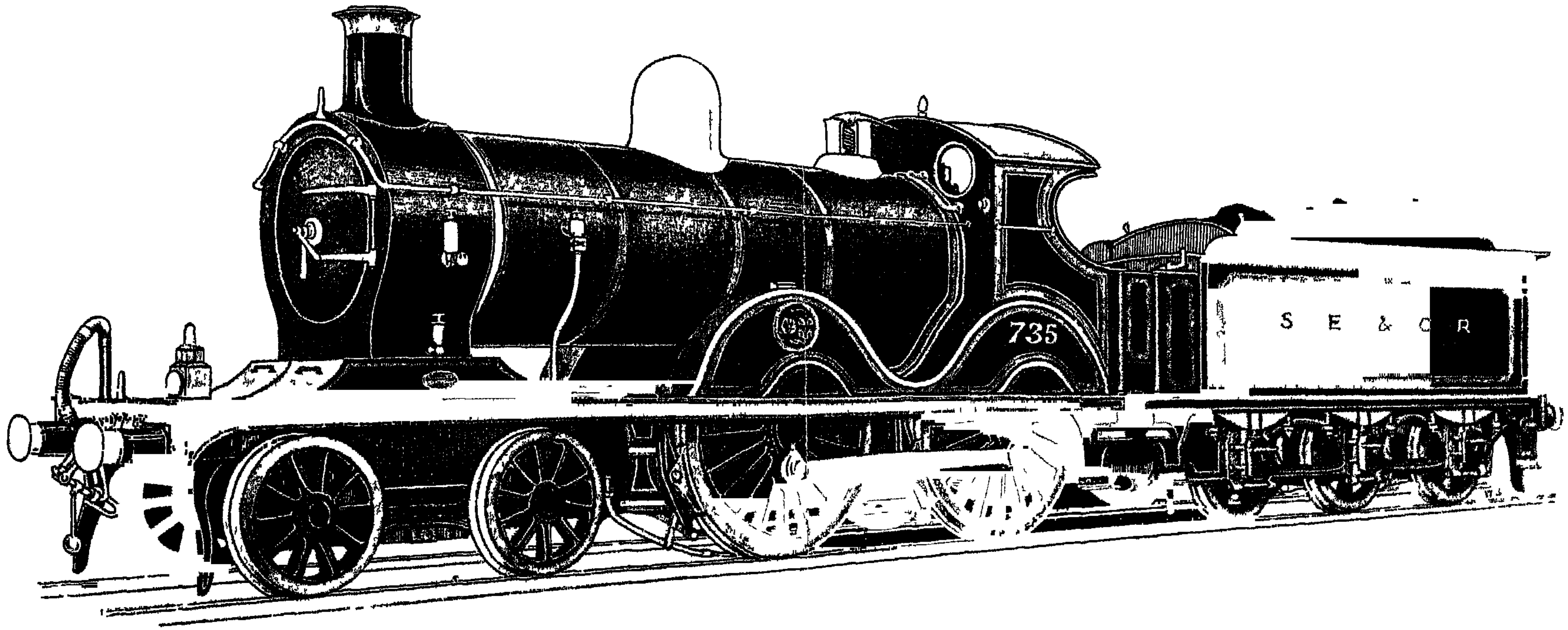
The Continental Express preparing to start from Charing Cross

The railways are said by some people to have been welcomed owing to the exorbitant charges and high profits of the canal companies There were, however, some canals that made no profits, and of such was the Thames & Medway projected in 1804 This went from Gravesend to Strood, and was a little over seven miles long, thus giving the barges a much shorter route to Chatham than round by Sea Reach if they would only have used it, which

they did not When practically insolvent it was taken over by a railway company who, converting only the part from Higham, opened a line from Gravesend to Strood in 1847 Here was a line in the wilderness that was not long to remain so, for two years afterwards came the North Kent from the Greenwich, through New Cross and Blackheath to Gravesend, which of course meant the purchase of the lonely railway and brought the South Eastern to Rochester Bridge on the way to Maidstone, which it reached from the north in 1856

In 1849 the line through Surrey was opened to Reading No one acquainted with the ways of our railways will be surprised at the South Eastern going west or even north-west, but this particular branch is due to amalgamation The route is of strategic importance, and, among the many schemes promoted in 1845, Parliament dealt with those for filling the gap between Redhill and Reading in such a way that the Reading, Guildford, & Reigate, and the Staines, Wokingham, & Woking, were authorised to construct and use the line which is now this part of the South Eastern, there being certain interchanges of running powers between the South Eastern and South Western In 1851 and 1852 Ashford and Tonbridge were looped up by the lines to Hastings, the next move being the business extension from Charlton to Angerstein's Wharf, the company's river port

The Chatham & Dover was now beginning to take shape, and for some seven years the South Eastern lay quiet preparing for the great effort by which its rival was not to be crushed This was its coming over the Thames to its big stations in the Strand and Cannon Street It meant two bridges across the river and the purchase of property at extortionate prices, and its cost was about £1000 a yard for a little over 2½ miles At Cannon Street an entirely new bridge had to be built, at Charing Cross the Hungerford suspension bridge had to be bought with



THE SOUTH EASTERN & CHATHAM RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 735

Designed by Mr Harry S Wainwright, M Inst C E

Boiler { Length 11′ 1″; Diameter 4′ 9″

Cylinders { Diameter 19¼″; Stroke 26″

Tubes No 263 „

Fire Box { Length 6′ 6″; Width 4′ 0½″

Heating Surface { Tubes 1381 sq ft; Fire box 124 „

Total 1505 sq ft

Diameter of Wheels { Bogie 3′ 7″; Coupled 6′ 8″

Grate Area 20 3 sq ft

Working Pressure } 180 lb per sq inch

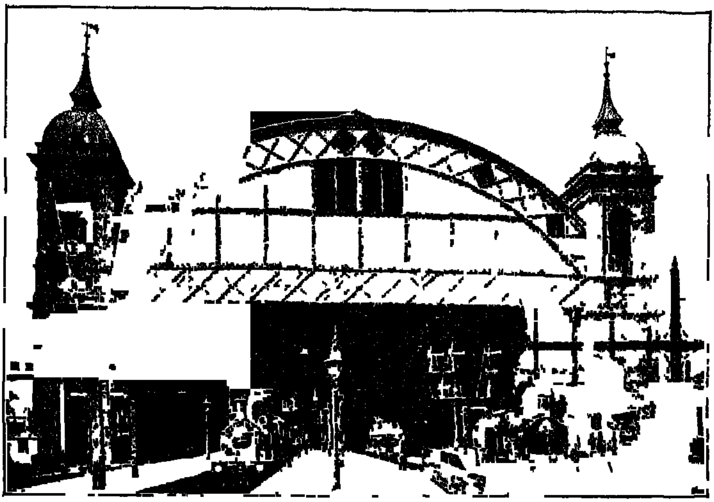
Weight in Working Order		Tons	Cwt
	Engine	50	0
	Tender	39	14
	Total Tons	89	14

Water Capacity 3300 galls

Coal Capacity 4½ tons

the obligation of retaining the footway, and though the old piers came in useful for some of the columns of the new bridge, foundations for the others were not so easily found

The station was built by an independent company and taken over by the South Eastern in 1864, it is not as it was, for owing to the failure of a tie-rod some of the original roof fell in 1905, and the remainder was taken down



Cannon Street Station—the City Terminus

for the present roof to be substituted The roof of Cannon Street Station is somewhat similar to the old one of Charing Cross, but is of better appearance and different in construction There are many who think that one of these stations would have been enough, but opinions are about equally divided as to which it should be, of one thing, however, there is no doubt, and that is that the working of the trains in and out of Cannon Street, with its crossing of the lines to Charing Cross, is almost as fatal to punctuality as the old arrangement between Croydon and Redhill

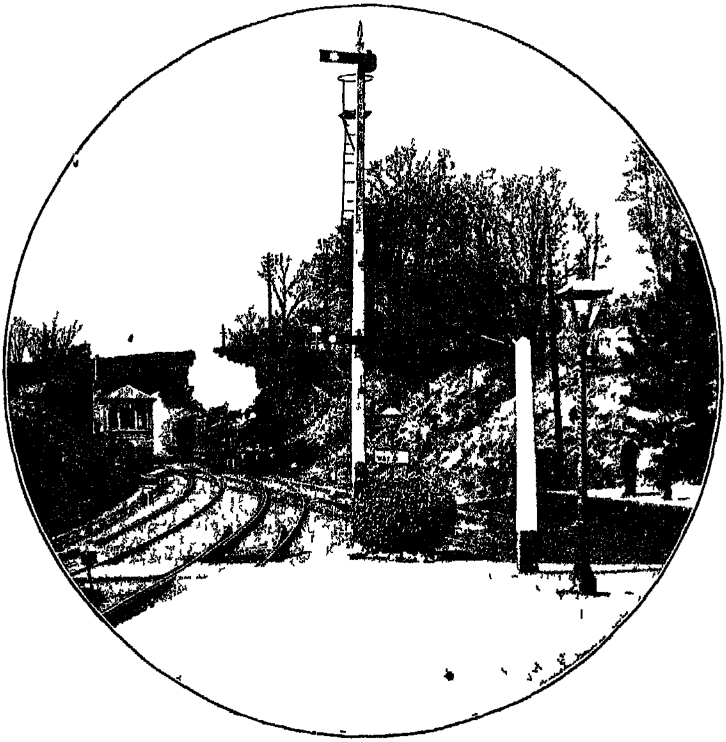
At the eastern end of the main platform at Waterloo

there is a single line leading out, which is occasionally used for passing troop trains through It belongs to the South Eastern, and was put there to give through communication between north and south when the Charing Cross line was opened and there was no Waterloo Junction but a station at Blackfriars Road In July 1865 a service of trains was put on from Euston through Kensington and Vauxhall that went over this line to London Bridge, and next year these trains ran into Cannon Street, further complicating the working and being little patronised The South Western complained that the South Eastern Company were deliberately discouraging the service, as they were, and at last gave that company notice to complete their engagements and build Waterloo Junction This, much against their will, they were compelled to do, for they had hoped to save the expense, but as some relief they asked that the through service should be taken off, and this was done on New Year's Day 1867 Meanwhile the competition of the Chatham & Dover had forced the South Eastern to find a shorter main road, and in 1868 there was opened the new route to Tonbridge through Sevenoaks, an extension of the line from St John's to Chislehurst completed four years before

The story of the London, Chatham, & Dover can be more briefly summarised It began with a building estate at Herne Bay belonging to George Burge who, under Telford, was the contractor for the St Katharine's Docks and the pier at Herne Bay along which the cars were driven by sails Burge had bought the property in the hope that some day a railway would come along to increase its value, and when the Central Kent was being surveyed he made the acquaintance of John Rennie's two assistants, Morris, who did so well afterwards in purchasing Folkestone Harbour, and Thomas Russell Crampton, a railway engineer of importance

Crampton, a Broadstairs man born in 1816, was a

fellow-apprentice of Frederick Bramwell's at John Hague's in Cable Street, and when his time was up was an assistant to Sir Marc Brunel until he entered the Great Western service under Daniel Gooch, for whom he made the drawings for the Firefly Leaving Gooch he went to Samuda's, where he had a hand in the machinery of the *Gipsy Queen*,



The Folkestone Express approaching Sandling

which was on a new principle, but, apparently being uncertain as to its safety, he obtained a berth under the Rennies on the 8th of November 1844—and four days afterwards came the trial trip of that ill-fated vessel when her boiler blew up and killed Jacob Samuda and four men

Before he left the Great Western he had begun to improve the locomotive, and in 1843 had sufficiently advanced to take out his first patent Leaving the Rennies in 1848, he started in practice on his own account, and began to develop his patent engines with the driving wheels behind the firebox, the first of which, the Namur, had been built to his design by Tulk & Ley the year before for the Namur & Liège Railway The Namur had been tried on the North Western, and had done so well that that company had given him an order for the London, followed by one for the famous Liverpool

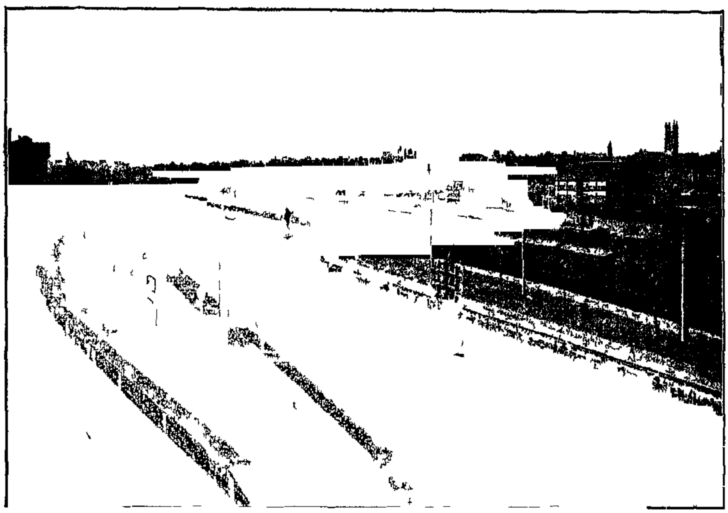
So many of Crampton's engines came to be used on the South Eastern and Chatham & Dover, that, though she belonged to another line, some particulars may be given here of this much-talked-about engine which attained a speed at times of 79 miles an hour She had eight wheels, six carriers of 48 in and a pair of 96 in drivers, she had outside cylinders 18 in by 24 in, her boiler was 12½ ft long and contained 300 tubes, and her heating surface was 2290 sq ft, the grate area being 21½ ft, over buffers her length was 27 ft, and she weighed 35 tons, that is 56 tons with the tender In one case this engine took along forty carriages and kept time, thus exceeding the combined power of three engines of the ordinary kind, but, as Bowen Cooke says, she played havoc with the inferior permanent way then in use, and was withdrawn in 1852

The Compagnie du Nord of France, agreeing in the advantages of her low centre of gravity, accessible working parts, and liberal bearing surfaces, ordered several like her In fact they worked their line with Cramptons from 1849 to 1876, and of one of their engines there is a working model at South Kensington which is most popular amongst the boys who like to see the wheels go round Crampton did something else besides designing locomotives, he it was who in 1851, taking over the enterprise in the time of difficulty, laid the first practicable submarine cable between Dover and Calais.

I—R 208

LONDON EXPRESS PASSING THE WARREN, BETWEEN DOVER AND FOLKESTONE

Burge wanted a line from London that would reach Herne Bay, Morris and Crampton thought there was an opening for a shorter road to Dover, and soon the three went into partnership and began seeking about for capital and support in the usual way to make one of the links in the projected route, that to Canterbury through Faversham from the North Kent at Rochester Bridge, with a branch from Faversham to Herne Bay to be made by the Kent



Ashford Junction

Coast Company "Morris, Crampton, and Burge," says Sir John Rennie, "commenced the London, Chatham, & Dover Railway with comparatively very little support for an undertaking of the kind, and experienced very great uphill work, so much so, that Burge got alarmed, and Morris and Crampton bought him out Morris and Crampton still struggled on with it, and then Morris went out, and Crampton remained alone At last he got Peto and Betts to join him, and then the concern went ahead Lord Sondes, a large landed proprietor in Norfolk and in

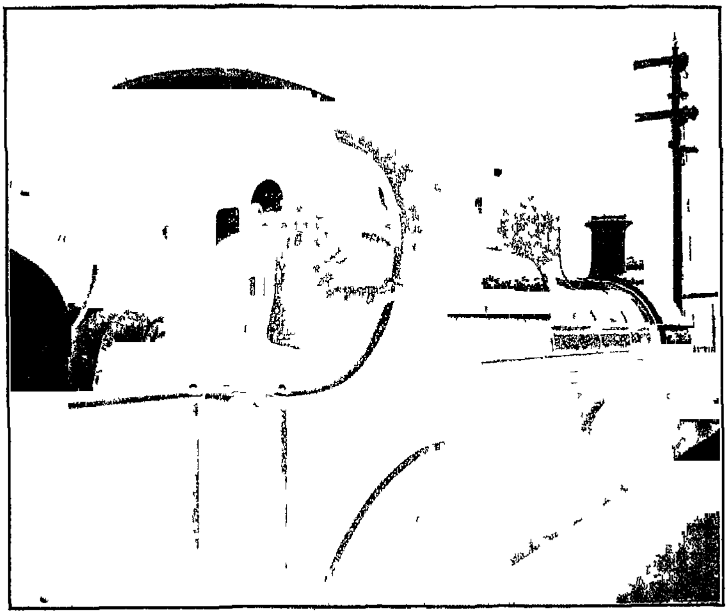
Kent, also joined them, and they completed the original line" And he might have added did something more, for with it in 1860 there was finished the line from Sittingbourne to Sheerness, which afterwards went to Queenborough, while the Kent Coast had got as far as Whitstable, and in addition to these the Bromley to Bickley line, which had been opened in 1858, was carried on to Rochester Bridge In 1861 the London, Chatham, & Dover, as it had become, reached Dover, and was ready to work with the boats that had been bought when the South Eastern refused them, and in another two years the Kent Coast was extended to Ramsgate, to become the property of the Chatham in 1871

Meanwhile it had been growing at the other end The year it reached Dover it was at Penge, the year it reached Ramsgate it was at Herne Hill, where it joined up with the section already made to the Elephant And thus it grew by small instalments until it arrived at Victoria and Ludgate Hill, and then the Viaduct and St Paul's, and could run on its own metals all the way How it was all done was a mystery on which some light was thrown when, in 1861, nearly every one connected with it went into bankruptcy, and Lord Salisbury and Lord Cairns began their three years' work as arbitrators, which ended in the Arbitration Act of 1869 with its drastic revision of the capital account

A road made by joining up short lengths in this way was not likely to be an easy one, and the Chatham & Dover track is the worst for speed running out of London For fifty of the miles between London and Dover the gradients range from 1 in 100 to 1 in 132, and only eighteen of the miles are easier than 1 in 200. For twenty-seven miles it undulates up to Sole Street, where it is 300 ft above sea-level, it then continues up and down, mostly down, to Canterbury, to rise for nine miles to Shepherd's Well, where it is 290 ft. above the sea and

there is a tunnel 2385 yards long, from which it drops for seven miles to the coast Add to this the many junctions and much suburban traffic, with almost every London company's goods and passenger trains on it, and the difficulty of managing it satisfactorily is evident

The old South Eastern by way of Redhill was easy enough, from Forest Hill onwards, as far as gradients



The Driver's Cab of No 315

and curves were concerned, but the present main line is quite another sort of road As soon as it passes St John's it begins to go up at 1 in 140, 1 in 120, 1 in 146, 1 in 310, 1 in 120, and 1 in 170 to Halstead; then down at 1 in 143, 1 in 204, and 1 in 150, and up from Dunton Green at 1 in 160 into Sevenoaks tunnel, 3451 yards in length, and down at 1 in 144 and 1 in 122 to Tonbridge, where it joins the old Cubitt line and runs nearly level to Headcorn,

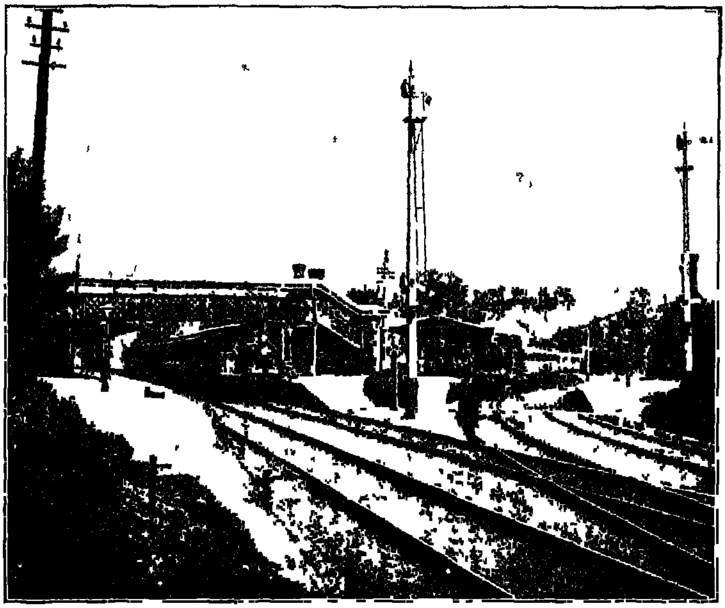
whence it rises from 100 ft to 280 ft at Saltwood tunnel, and by a falling gradient averaging 1 in 260 for the twelve miles reaches Dover

The long pull up out of London, to say nothing of the hindrances north of Hither Green, is responsible for a great deal of the South Eastern's reputation for slowness, but considering the weight of the trains it is by no means bad going, and could not be so well done if it were not for the really good engines that work its best trains The engines are good enough, the permanent way is of the best, the rails, 91 lb to the yard, are heavy enough, and yet, for the reasons mentioned, no company gives you so much of its time for the money.

Ashford Station, that site of many changes, has been quite transformed from what it used to be As rebuilt it is one of the largest and most convenient junction stations that any company possesses, and there are rumours of much improvement in the services of the lines beyond It has had a long history, for it was opened in 1842, five years before the locomotive works were ready to begin business Prior to that they were at New Cross, in the shed now used by the Brighton Company for its London Bridge engines

The first engines for the line were supplied by Sharp, Roberts, & Co, and soon went into the general stock of the old Joint Committee When the Committee was dissolved the engines were shared among the companies, the South Eastern taking most of those originally belonging to it and a few more that had belonged to the London & Croydon Then came batches of twos, threes, fours, and sixes from builders like Nasmyth, Bury, Tulk & Ley, Jones & Potts, and Forester up till 1851, when ten new Cramptons from the Stephensons were put on the line to wake it up a bit One of these, No 136, the Folkestone, was in the 1851 Exhibition along with the company's "London and Europe Carriage," an eight-wheeler jointed

in the middle to allow it to take the curves easily This engine ran from Redhill to Tonbridge, 19½ miles, at an average rate of sixty miles an hour, and at times attained seventy-five, and from Tonbridge to Ashford, 26½ miles, at the average rate of seventy-eight, the whole forty-six miles taking forty minutes, which will show what the rear-



Sandling Junction—Hythe Branch on the right

drivers could do though we may not think much of them now She was a six-wheeler 4–2–0 with 42 in carrying wheels and a pair of 6 ft drivers, her cylinders being 15 by 22, and her weight 26½ tons

In 1853, James Janson Cudworth built the first engine at Ashford—a 4-coupled passenger with 5 ft 6 in wheels, 15 in. by 20 in cylinders, a heating surface of 1123, and a weight of 26 tons This was one of the eleven known for years as Hastings engines, all of which had "Cudworth's

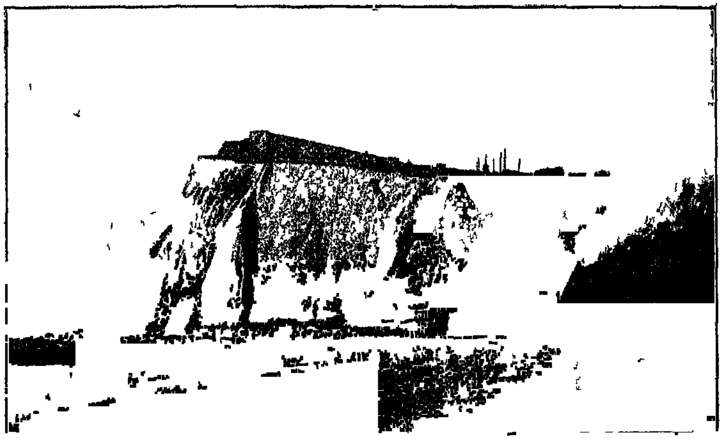
compensating spring gear for coupled wheels," recognisable at once by the bar above the splashers Three years afterwards Cudworth began to build his 6 ft singles, which had cylinders 15 in by 22 in a heating surface of 1191, and a weight of 27½ tons, and next year, 1857, he introduced his coal-burners

It was in October and November of that year that he made his experiments with No 142 This was fitted with a long, sloping firebox 7 ft 6 in in length, the grate being 7 ft, the box being divided into halves by a longitudinal mid-feather forming two furnaces with separate doors, the furnaces uniting in front of the tube-plate The furnaces were fired alternately, the coal being put just within the doors and shaken down along the sloping floor by the movement of the engine so as to separate the smoke from the fresh coal and consume it by the incandescent mass at the lower end as it was passing into the tubes

During 1857 Cudworth put on the line the first of his large class of goods engines, two of which, built in 1863, had Mansell wooden wheels In 1861 came the first of his 7 ft singles, 2–2–2, with 4 ft 9 in leading wheels and 4 ft trailers These also had two grates, their heating surface was 1137 and their weight 33½ tons, their working pressure being 130 Most of them had 17 by 22 cylinders, some had cylinders an inch less in diameter, and it was one of these, No 81, painted blue and named the Flying Dutchman, that worked the royal trains Owing to the directors ignoring him in ordering the 259 class of Ramsbottoms, Cudworth resigned, and his place was taken by Alfred Watkin, on whose resignation Ashford was managed by R C. Mansell until the coming of James Stirling, the very man that was wanted

He made havoc of what was irreverently known as the museum, and left the line with a new stock of engines, nearly all of which were designed by himself. The

requirements of the traffic when he took over were on a far larger scale than they had been, and his engines had to be of much more power and weight One of his engines, No 240, was prominent at the Paris Exhibition of 1889—it was awarded a gold medal, as the Folkestone was in 1851, though there is not much in that except that the 1851 medals were the only ones worth having—and fully deserved the notice it obtained It weighed $42\frac{1}{2}$ tons, while its tender weighed $30\frac{1}{2}$ tons, that is 73 tons altogether This was a great advance , a 4–4–0, the bogie wheels 3 ft 9 in , the



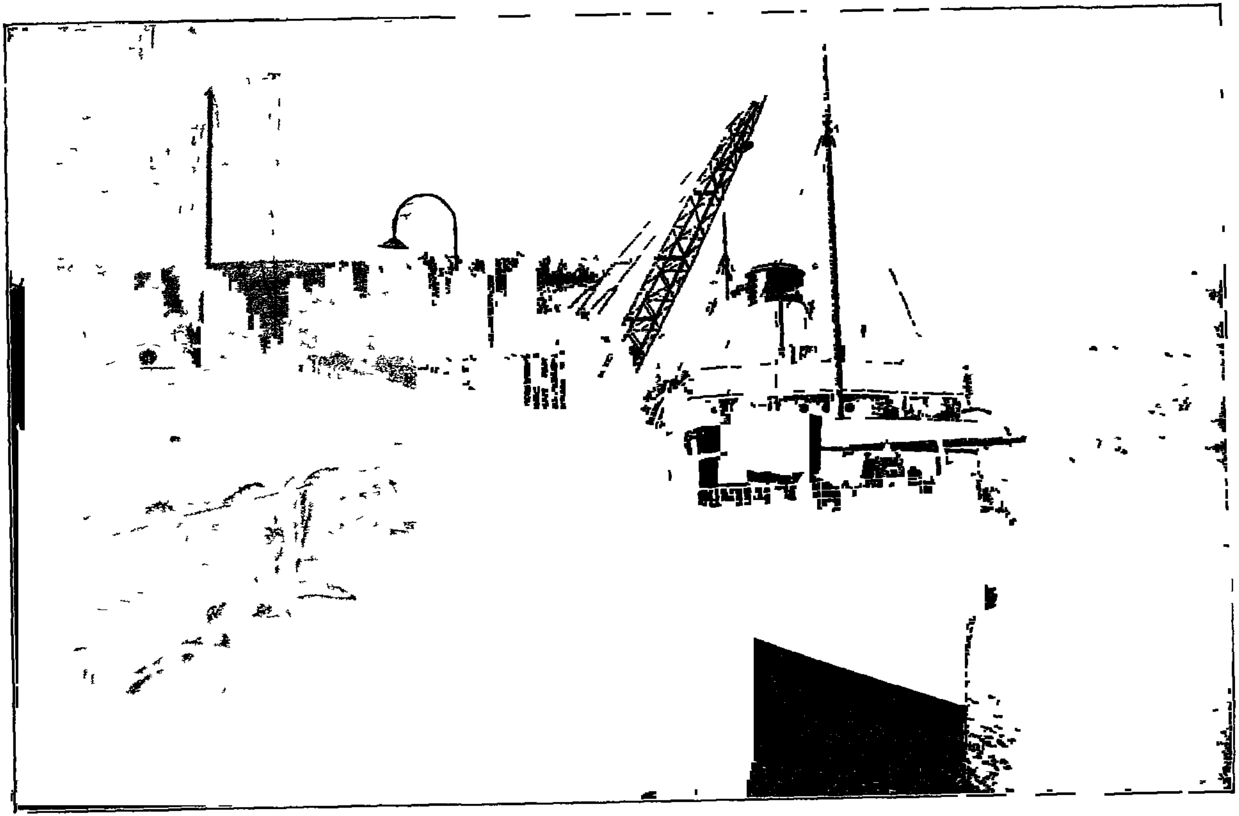
Shakspeare Cliff and Tunnels, near Dover

trailers and drivers 7 ft , the cylinders being 19 by 26, more like what would have been expected This engine, like all its class and all the other classes, was fitted with his reversing gear, often mistaken for a Westinghouse brake-pump, though it is farther along and on the right-hand side instead of the left, the visible sign being two vertical cylinders at the side of the boiler barrel, one over the other, with a piston rod through both communicating with the levers below There is steam in one cylinder and oil or water in the other, and to work the gear two handles are

used, one to give the direction to the motion and the other to control the steam supply to the upper cylinder and so regulate the passage of the fluid from one side of the piston to the other in the lower cylinder The steam places the piston in any required position for forward or back gear or expansive working, and the fluid keeps the piston in that position The advantages of this contrivance are that it not only acts quickly but requires practically no manual exertion

Mr Stirling was succeeded by Mr H S Wainwright, whose fine engine No 516 was conspicuous as the only British locomotive at the Franco-British Exhibition of 1908 This belongs to the class known as E, which began with No 273 and were the first of the line to be fitted with Belpaire fireboxes She is a 4-4-0, her driving wheels being 6 ft 6 in and her bogie wheels 3 ft 6 in , her cylinders are 19¼ in by 26 in , the heating surface of her tubes is 1396 sq ft , and that of her firebox 136 sq ft , making 1532 in all, and her grate area is 21 15 sq ft , and the working pressure is 180 She weighs 52 tons 5 cwt , and her tender weighs 39 tons 2 cwt , has six 4-ft wheels, and carries 4 tons of coal and 3450 gallons of water , thus engine and tender weigh 91 tons 7 cwt , and over buffers they measure 55 ft 1⅝ in

The Chatham & Dover locomotive works were at Longhedge in Battersea, now used as a branch for repairs, all the new work being done at Ashford The later engines by Mr Kirtley, particularly those for the Continental trains and the tanks for Metropolitan work, were much better than they got credit for, except amongst engineers, but they came during the intermediate period when there was little of general interest in the experimental way, and further building was put an end to by the amalgamation in 1899. The carriage works are also at Ashford, and the newer coaches are excellent specimens of workmanship, there having been a great improvement in the general rolling stock



I—R 217

ARRIVAL OF THE BOAT TRAIN AT DOVER. R.M.S. *EMPRESS* PREPARING TO LEAVE FOR CALAIS

American cars—Gilberts, not Pullmans—were introduced in March 1892, and the car trains have always been up to the average of those of other lines, in fact it is not true that the carriages on the Continental route are worse on this side of the Channel than they are on the other

Of course the South Eastern must be in the fashion and have its motor trains, and on some of its branches nothing more is required It has a good many branches and cross-roads with a future before them after a sleepy past, many of them made in the old competition days for competitive purposes only—" suckers " one of the chairmen used to call them—which are now in course of development

Ashford is not the only station which has been greatly improved Victoria has been taken in hand with remarkable success and become quite a handsome, roomy terminus The new building bears on its front the name of the Great Western as well as that of the South Eastern, to mark its joint ownership dating from the days when its rails were both broad and narrow gauge In fact the London termini, Victoria, Charing Cross, Holborn Viaduct, St Paul's, and Cannon Street, are all good, and Ludgate Hill, which was once a terminus as Blackfriars used to be, has been rebuilt as an intermediate station to great advantage, though, to spoil the view of the cathedral from Fleet Street, the signals remain on the redecorated bridge which gives bold display to the company's arms, the special bearings of the old South Eastern with the " Onward " that used to be so inappropriate, and the four shields, Kent, London, Dover, and Rochester (with the old English r on the cross) that distinguishes the London, Chatham, & Dover

There is no company better provided with London stations Of the 667 miles of railway in Greater London it owns 124, and of the 609 stations within that area it owns 98, 6 of them being north of the Thames. Its own metals run in from Herne Hill to Snow Hill Junction in the direction of Moorgate Street—the intervening line belong-

ing to the Metropolitan—and by Brixton to Victoria From Greenwich round to Brixton it spreads its net over the south-east and south, and with its inner loop of the extension it taps the south-west At Victoria it is in footway communication with the Dis' ct, at Charing Cross it is served by the District, the Baker Street & Waterloo, and the Hampstead, at Cannon Street it again has the District, at London Bridge, as at Moorgate, it has the South London, and at Moorgate it has the Metropolitan, the Midland, and the Great Northern At London Bridge it has the Brighton, at Victoria it has the Brighton and the Great Western, and at Waterloo Junction it has the South Western, as it has at Clapham Junction

That it has a large local traffic is shown by its season tickets, from which it obtains a greater revenue than any other line except the Great Eastern But the Great Eastern amount includes over £71,000 for workmen's tickets, which on the South Eastern reach only £38,000 As the Great Eastern total is £410,489, and the South Eastern's £392,118, the difference, £33,000, would put the South Eastern at the head of the season-ticket list in the usual meaning of the term So important is its season-ticket business that to have some check on the vagaries of its passengers it initiated in 1869 the system of travelling examiners boarding trains in motion, their first day's work realising over £8 Out of its 63 millions of passengers of all kinds the South Eastern makes a revenue of £3,400,000, its total traffic revenue being £5,000,000, and to earn this it uses 15,000 vehicles drawn by some 750 engines for 15,000,000 miles

The South Eastern carries the Continental and Indian and Australian mails From Queenborough go the Dutch boats to Flushing, from Folkestone goes the quickest route to Paris, from Dover go the Belgian boats to Ostend and the British and French boats to Calais with the mails on their way to Marseilles, Naples, and Brindisi, and practically everywhere in Europe and Asia, and the mail starting

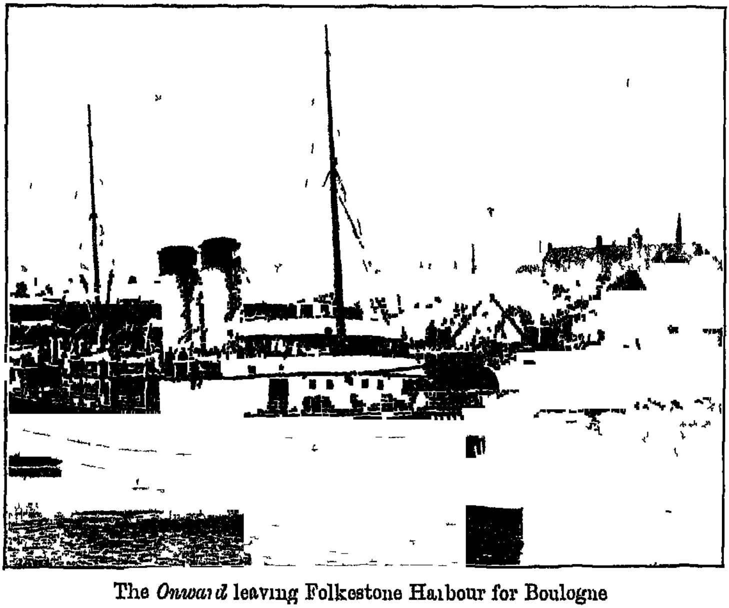
with its hundreds of sacks, or being shipped at Dover, is a sight to see Queenborough is a pier and nothing more, Folkestone is an ordinary harbour, but Dover in the present day is a wonder The Admiralty pier, begun in 1847, has been extended from 1550 ft to 3550 ft to form the south-western arm of the harbour of refuge The eastern arm runs out for 3120 ft towards the south-eastern entrance, and the southern breakwater, with a length of 4200 ft, completes an artificial harbour which, including the

Dover Harbour

commercial portion within the Prince of Wales pier, covers an area of over a square mile Simple as it looks, it cost more than 3½ millions of money, most of it put under water

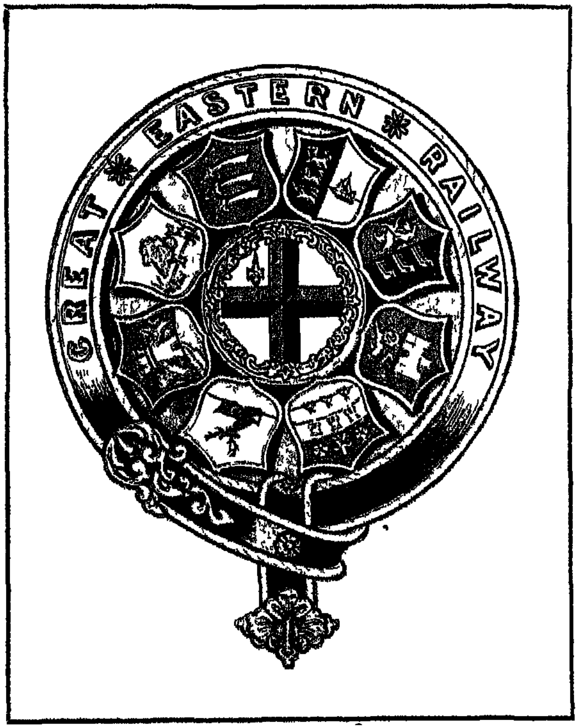
To say nothing about naval matters and ocean liners, there is no doubt about the increase in the trade, and the railway people very naturally do their best to foster it At the new Marine Station close to the "Lord Warden," erected by arrangement between the Dover Harbour Board and the railway company, the cross-channel traffic is for the future to be dealt with and passengers will be able to

make a comfortable departure or arrival The company have a fleet of eighteen vessels of their own either here or at Folkestone, most of them here, and of these eight are cargo steamers The others are fast passenger boats, five of them turbines, travelling at over 20 knots, two of them doing 22½, all of them over 320 ft in length and 42 ft in beam, the *Empress*, *Victoria*, and *Invicta* being stationed at Dover, the *Onward* and *Queen* at Folkestone Very different this to the old days of the boats that were not good enough for the company to buy when there were two expresses to France in a day, one from each port, there being now five, three to Calais and two to Boulogne.

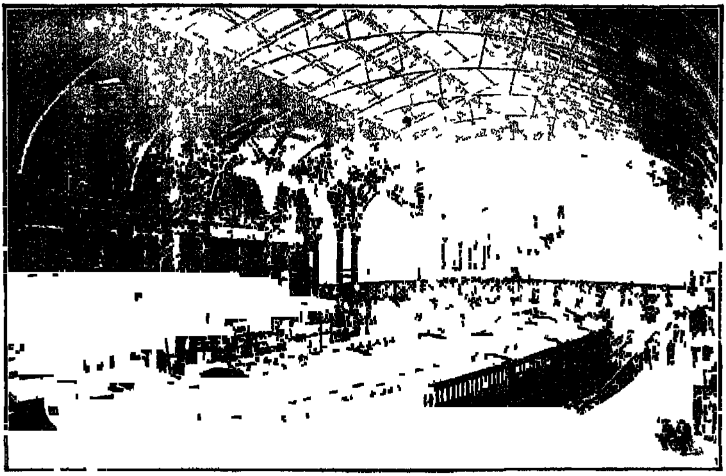


The *Onward* leaving Folkestone Harbour for Boulogne

THE GREAT EASTERN



COAT-OF-ARMS



Liverpool Street Station—Main Line Platforms

THE GREAT EASTERN

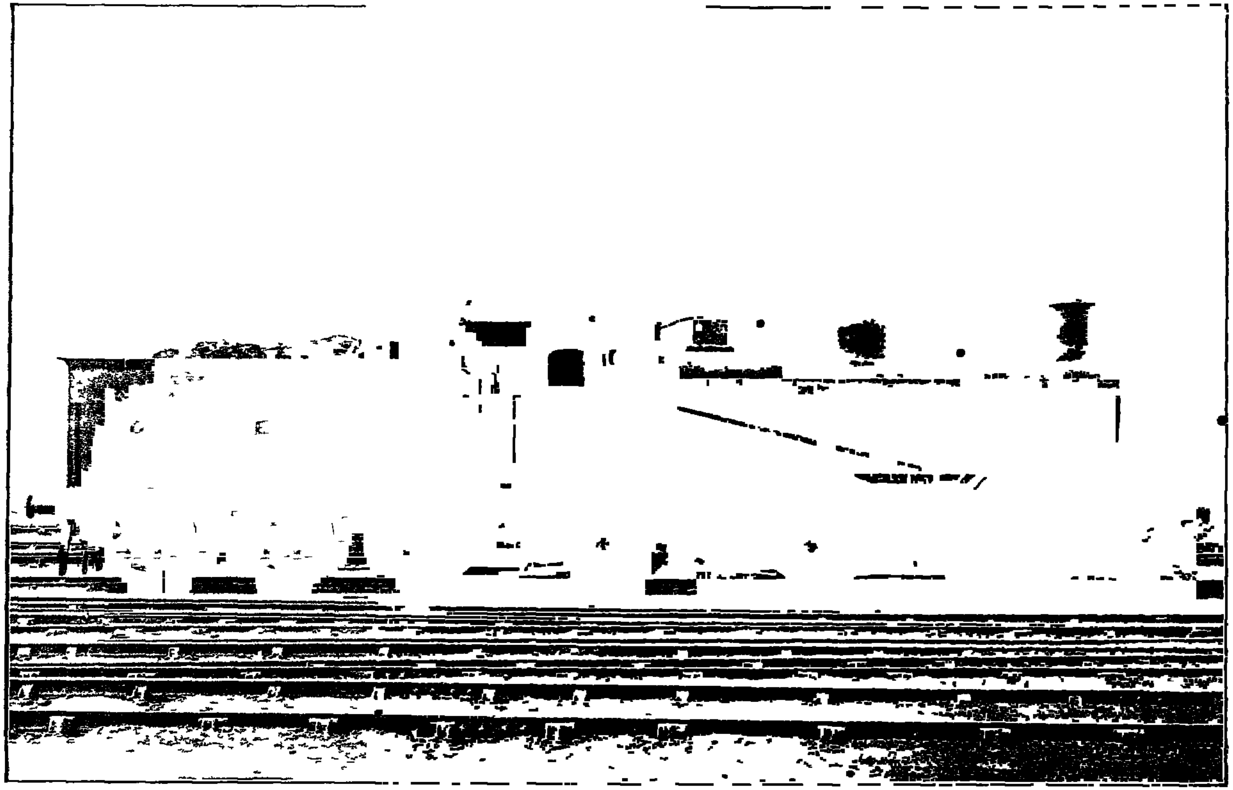
The Great Eastern is our greatest passenger line, for over 103 millions travel on it in a year, and it is the sixth in order of our great lines, the length being over 1200 miles, thus exceeding both the South Western and the Great Northern "Friendly with all companies," it was for years an example of a really well-managed concern that progressed without competition

Through the greater part of its history, with the exception of the early parliamentary contests with the Great Northern, which ended in its being confined to that section of the country it was specially projected to serve, it was without any such "spur" as rivalry is assumed to give Some years ago Sir George Gibb astonished an interviewer by telling him of the North Eastern, a line similarly placed, that "monopoly secures harmonious, consistent, and well-ordered progress," and the Great Eastern, ever since the

days of the Marquess of Salisbury, afforded until recently another example of the truth of that doctrine It is careful not to promise what it cannot perform, and, though not speedy in its fastest trains, its general average of speed for all trains is higher than that of any other company Its suburban traffic is tremendous, and its goods traffic, 5½ million tons of it a year, is most miscellaneous

The way it has fostered local produce and local industries is worthy of all praise Think of the millions of herrings and trawl-fish it distributes from Yarmouth and its own docks at Lowestoft, the sprats from Aldeburgh, the shrimps—a thousand tons a year of them—from Harwich, the crabs from Cromer, the cockles from Wells, the oysters from Brightlingsea Think of the grain and fruit and market-garden stuff it pours into London from all over its area Think of the mustard and boots it scatters from Norwich, the chemicals from the marshes, the xylonite from Manningtree, the rifles from Enfield, the cordite from Waltham and Hadham, and the gun-cotton from Stowmarket With the aid of the London & Blackwall it has a large dock and shipping business irrespective of what it may do at Parkeston, where it brings in almost everything from everywhere on the Continent Add to this its passenger matters with the Broads and the towns of the east coast, the multitudes it runs to the Forest and the greater multitudes it carries in and out to business, and you will understand that it has quite enough upon its hands besides the sale of sea-water by the gallon for London's baths.

From Lowestoft to Huntingdon, from Shoreditch to Peterborough it has covered the east country between the Thames and the Wash with a network of rails having some forty loose ends, half of them ending on the coast, which has linked up every place of any importance and many that are of none, and north of that, through Spalding and Lincoln, it works right away to York and Chesterfield in search mainly of a coal trade that is ever increasing and



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MAIN LINE GOODS ENGINE, NO 1189

now reaches 7½ millions of tons a year, obtained by its arrangements with the Great Central and Great Northern

The ring of shields round London on its coat of arms tells you where it goes—Essex, Maldon, Ipswich, Norwich, Huntingdonshire, Cambridge, Hertford, Northamptonshire By its close upon 1100 engines its passenger trains are run thirteen million miles and its goods trains eight millions of miles a year, and it has over 32,000 vehicles on its rails in addition to over a score of motor-cars, about 1300 horse-drawn carts, wagons, and omnibuses, and a fleet of fifteen steamers In fact no one would imagine from the position in which its enterprising management has placed it that in 1867 it was in such low water that its creditors seized its engines for debt

The Great Eastern is a railway with a past, in the usual acceptation of the term. From being nearly the worst of railways it has become one of the best Those who have read about its territory in books know it as a flat country, those who have been there know that, with the exception of the north-western corner, it is anything but flat, being an undulating land with very little level in it It was a tempting region for cheap railways laid practically on the natural lie of the ground, and thus it came about that the Great Eastern, which is an assemblage mainly of farmers' lines, with many sharp curves and steep gradients, is really not an easy road to work

It began with the Eastern Counties, a 5-ft line, which the Northern & Eastern, also a 5-ft line, joined in 1844, three months before the change of gauge Then there was the Norwich & Yarmouth which for years held the sprint record—one mile in 44 seconds—and was also the first to make trial of a telegraph system that showed the passage of the trains at its five chief stations, introduced on the opening day in 1844 It did not last long alone, for that year it joined with the Norwich & Brandon to become the Norfolk Railway, and four years afterwards

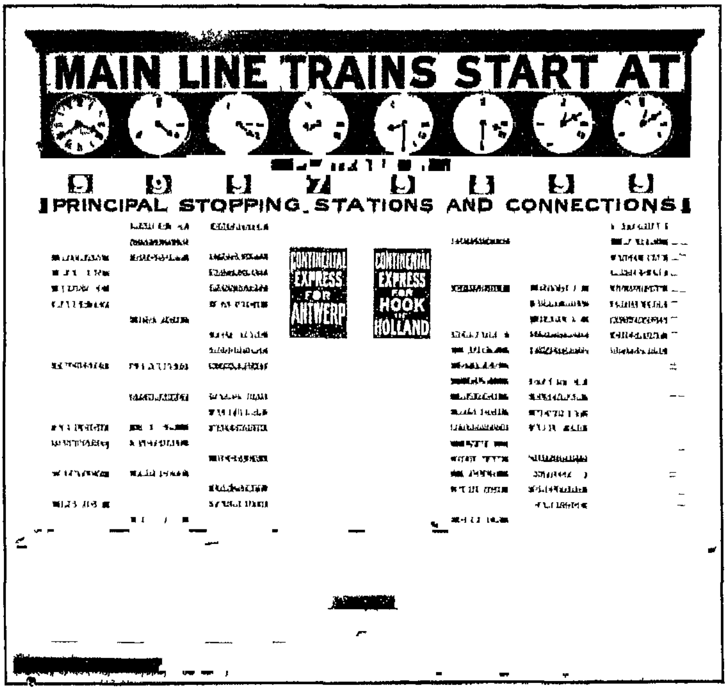
the Norfolk joined with the Lowestoft to be worked by the Eastern Counties Then there was the Eastern Union which amalgamated with the Ipswich & Bury and came to lease the Colchester, Stour Valley, Sudbury & Halstead, all of them falling into the net of the Eastern Counties in 1854 Into that net had also fallen the East Anglian, an amalgamation of the Lynn & Ely, the Lynn & Dereham, and the Ely & Huntingdon The Newmarket, the Wells & Fakenham, and the East Suffolk followed suit, and—but we may get lost among the details, and enough has been said to show how the Great Eastern, which took the name in 1862, has been built up

The engineer of the Eastern Counties was John Braithwaite, who, in partnership with Ericsson, built the Novelty for the Rainhill race, the engine for John Ross's *Victory*, and much other machinery that failed, sometimes from no fault of its own, as, for instance, the first steam fire-engine, which the mob smashed up In short, his experiences were not encouraging, and in 1834 he took to civil engineering, an offer having been made him to survey for a new railway in Essex in conjunction with Vignoles

Vignoles did nearly all the work, though he took little part in the affairs of the company after the Act was obtained in 1836, five years after the project had been launched, when Braithwaite was left to go ahead alone The line was to run from High Street, Shoreditch, by Colchester, to Norwich and Yarmouth, the longest line up to then projected, its length being 126 miles Under another Act the Northern & Eastern was to start from a junction with it at Angel Lane, Stratford, and proceed to Bishop's Stortford, and this company was fortunate, for the only difficult section was that between Shoreditch and Stratford

Here Braithwaite had many calls on his peculiar gift for making the best of things The marshes were for a time insatiable, they swallowed up all the materials dumped on them to form the embankment, and when at last the

embankment ceased to sink into the ground it simply spread and would not hold together As time was getting on, Braithwaite decided to treble the rate of accumulation, and built a staging in advance from which the wagons could be tipped side by side This brought up the earth-



The Train Indicator at Liverpool Street

work quickly enough round the stage, but the posts could not be readily moved to take the stage on farther And he left them where they were and their lower framework with them, and went on building stage after stage in a manner new but now familiar, leaving the piles as he went, and there they are still, ensuring the permanence of the embankment To drive these piles he was the first to use the American locomotive steam pile-driving machine, just

as he was the first to introduce the American excavator to make his cuttings with

Braithwaite had no conception of the magnitude of the work he was beginning, he was the narrowest in vision of all these engineers He laid out the line to a 5-ft gauge, and was the first witness called by the Gauge Commission "Having adopted a wider gauge than others," he said, "an impression has been created that I am a Broad Gauge man, but I state most distinctly that I am not a Broad Gauge man and I see no necessity for the Broad Gauge" And then listen to this "If the object were that all the world might leave London in the morning and come back at night, you would want magnificent gradients such as on the Great Western with the Broad Gauge" O Shade of Braithwaite! Meet us at Liverpool Street on Saturday afternoon!

His directors wanted the 7-ft gauge, and he reported against it and persuaded them to adopt this little gauge of his own But why 5 ft instead of 4 ft 8½ in? This is his answer verbatim. "With a little more space between the tubes we should have a more quiet action of the water in the boiler and consequently less ebullition, and therefore with my diagram and my section of my engine, I added to all its different bearings, and I added what I considered sufficient additional space to the tubes, the sum of which gave me 4 ft 11¾ in, and upon that I assumed that 5 ft would be about the thing"

With this in mind let us refer to the first engines that were placed on this 5-ft line They were designed by Braithwaite, and were the engines he speaks of There were six of them, the four first to be delivered had 12 in by 18 in cylinders, the other two had 13 in by 18 in cylinders, otherwise they were all alike, they had four wheels, the leaders being 54 in and the drivers 72 in, the heating surface was 428 sq ft, the boiler had 84 tubes of 1⅝ in, and its diameter, with the additional space for

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THE KITCHEN CAR OF THE NORFOLK COAST EXPRESS

the less ebullition, etc, was 3 ft 3 in Thus the greater room he obtained by his 5-ft gauge enabled him to produce a boiler of less diameter than that of the Rocket! And that is all that need be said about Braithwaite, except that the line he laid had to be taken up and replaced, eighty-four miles of it, at a cost of £1000 a mile, and that he ceased to have anything to do with the company after May 1843

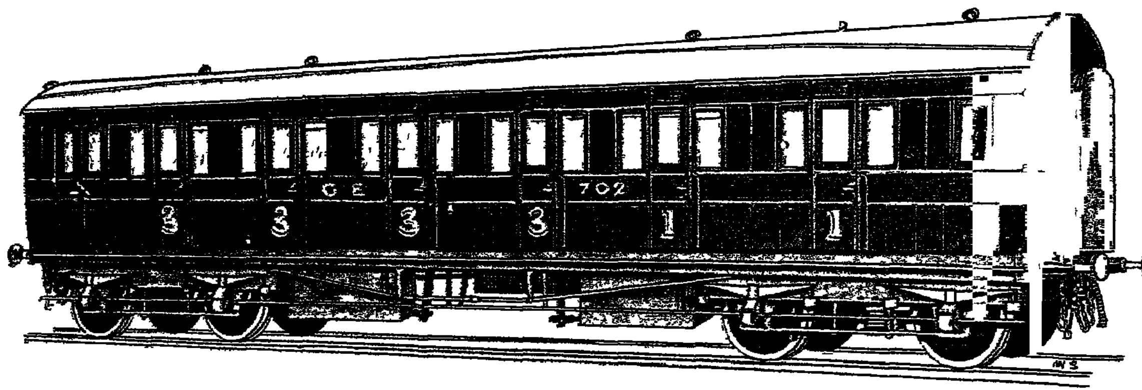
Shoreditch, that is Bishopsgate as we now know it, was the original terminus, but, owing to the station not being ready, the Eastern Counties was opened on Waterloo Day 1839 from Devonshire Street Liverpool Street was not opened until the 2nd of February 1874, and then only for local trains, the terminus not getting into full swing until the 1st of the following November This magnificent station, which cost over two millions of money, covers over sixteen acres and has over two miles of platform faces

The local traffic north and east is so varied and abounding that the main-line trains are not clear of suburban troubles until they are beyond Tottenham and Romford Up to Bethnal Green the road rises for nearly half a mile at a gradient of 1 in 71 Along the Colchester line, the original track, it rises gently until for the last three miles to Brentwood the gradient is 1 in 95, then it falls to Colchester and undulates at from 1 in 100 to 1 in 150 all the way to Yarmouth Along the Cambridge line, the old Northern & Eastern, most of which was made by Morton Peto, it rises to Elsenham, the last five miles being at 1 in 130, and then it drops at 1 in 230, practically all the way to Cambridge, north of which it is level Elsenham used to be the summit level of the system, but that height, 340 ft, is now reached between Epping and North Weald on the road to Ongar Up in the Fenland about March the Great Eastern has the flattest, dreariest district known to the railway traveller, a country in which the waterways are parallel straight lines and the marshes lead up without even a hillock right away to the unbroken horizon, a scene

so deadly dull that it is impossible to read and the passenger takes to whittling sticks

The longest tunnel, for the Great Eastern has tunnels, is between Newmarket and Warren Hill, the most interesting viaduct is that at Lakenham, between Swainsthorpe and Norwich, which was built in 1848 and carries the old Eastern Union over the River Yare and the Cambridge line For the illustrations of this and of the Trowse and Reedham swing bridges we are indebted to the courtesy of the engineer, who tells us that "the Trowse Swing Bridge over the River Wensum between Trowse and Norwich was rebuilt in 1905 There are two viaduct spans of 24 ft each The swing portion is equal-armed and 121 ft over all, crossing a 45-ft span on each side of the centre, only one of which is navigable The bridge is worked electrically from a cabin at the centre, and the wedging blocks at each end are released by hydraulic jacks worked direct from a pump coupled to an electric motor Reedham Swing Bridge over the River Yare between Reedham and Haddiscoe was rebuilt in 1904 There are three viaduct spans of 33 ft 6 in and two of 27 ft. 6 in The swing portion is equal-armed and 141 ft over all, crossing a 55-ft span on each side of the centre, only one of which is navigable The bridge is worked electrically from the cabin seen on the right in the photograph, and the wedging blocks on the centre pier are released by hydraulic jacks worked direct from a pump in the cabin" These bridges and the two at Carlton Colville and Somerleyton, which so frequently block the way, are perhaps the most interesting features in the civil engineering work on the Great Eastern.

Lakenham is of course a little thing compared with the roads on arches in the London district. There is one of these, nearly two miles long, from Stepney to Bow that cost a quarter of a million, and remained in the wilderness for years owing to the Eastern Counties declining to lay the junction rails. This belongs to the London & Black-



THE GREAT EASTERN RAILWAY

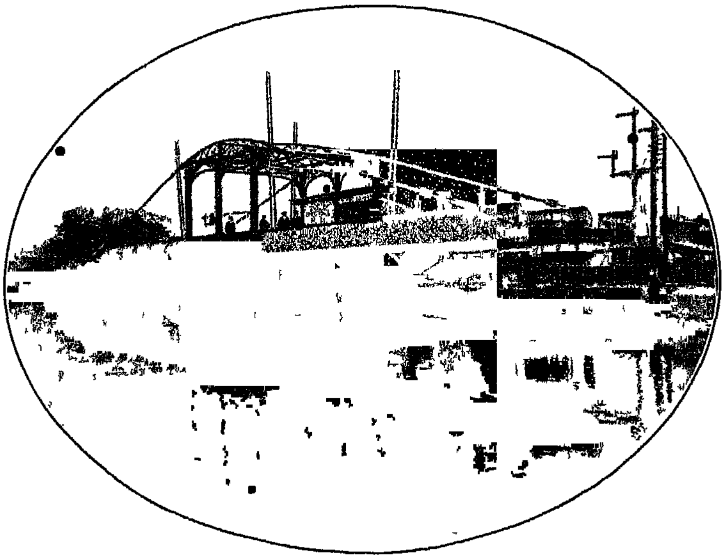
Composite Carriage No 702 Standard Type

Extreme length 50′
,, width 8′ 9″
,, height from rail 12′ 5″
Carried on two 4-wheel bogies

Seating capacity {First class 12, Third ,, 32 •}
Through corridor connection with flexible gangways
First class, upholstered in blue cloth and crimson leather in smoking compartment
•Third ,, ,, ,, crimson and black plush

Electric lighting
Lavatory accommodation
Vacuum brake
Burnished brass fittings

wall, which was built mainly on arches and began as no other railway began It was Rennie's original scheme for putting London into communication with the eastern counties, the idea being to connect the City with the docks and continue the line as a grand trunk route through East



The Trowse Swing Bridge, near Norwich

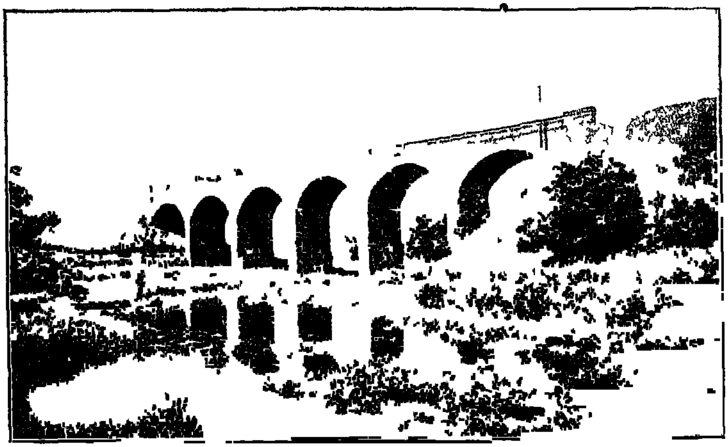
Anglia. The great scheme failed to secure support, while the Eastern Counties obtained the Act for their line which left the docks for another company to deal with Then Rennie, cutting off his continuation, formed a company for a line from Blackwall only to Fenchurch Street, to be worked by locomotives, and some one in the City seeing its importance secured Robert Stephenson as the engineer of an opposition line to be worked by ropes A Bill for each was introduced into Parliament, and Rennie's passed while Stephenson's did not, but Rennie's people could not raise enough money and Stephenson's could, and so Stephenson's London & Blackwall company bought up

Rennie's Commercial, and Stephenson became the engineer of the line that was made

As it was mentioned in the Act, which was obtained in 1836, he had to adopt a gauge of 5 ft $0\frac{1}{2}$ in, another of Rennie's trivial variations, and the line was so short that he thought it would not pay to use locomotives It measured $3\frac{1}{2}$ miles, and was worked by two endless ropes, one for the up line, one for the down, some fourteen miles of rope in all The working was on the slip principle, the two front coaches going through, the third slipping off at Poplar as did one for every station, the last being for Shadwell, the first station of the seven on the road On the up journey the coaches were each pinned on at the same time, so that they came into Fenchurch Street separately with the same intervals between them as there were between the stations, all but the Blackwall pair which arrived together Really an ingenious and remarkable railway, the only one on which the train started from every station at the same time, and on it was used Cooke & Wheatstone's new galvanic telegraph Needless to say the ropes wore out and were abandoned for locomotives, the stationary engines were removed to the City Flour Mills near Blackfriars Bridge, and the line—opened in 1840—which soon became the dirtiest in the south of England, ended its separate existence in 1865 when the Great Eastern took it over, and thus obtained a second London terminus, the right to run into St Pancras making a third

Slipping the end carriage or carriages, not, however, in Blackwall style, is still practised, though not to the same extent as formerly, and the Great Eastern has more slips than any other line except the Great Western, which has more than double as many In the old separate brake days there was no trouble about this slipping, but when the continuous brakes came in there were difficulties concerning the brake-hose, which put it out of fashion until the needful invention got a chance

The slipping apparatus consists of a hinged hook which opens by the withdrawal of a pin or some other obvious device Before it is put into action, the valve in the air-pipe is turned off by the guard in the carriage that is to be detached, either by pulling a cord or by reaching his arm out of the window, the uncoupling of the carriage and the shutting of the valve being sometimes worked pneumatically The communication being cut off, the slip-carriage becomes a self-contained unit with a small supply of brake-power of its own in addition to that afforded by the hand brake



Lakenham Viaduct

When the carriage is to be slipped the train is checked in speed slightly, so as to relieve the couplings a little, and on the communication being severed the train increases in speed so as to get out of the way as soon as possible The distance from the station at which the carriage is set free depends upon the speed, the gradient, and the slipperiness of the rail, which is dependent on the weather One frosty day, for instance, when snow lay deep on the ground, the writer was in a slip for Luton which travelled through that station half the way to

Leagrave, and had to be pushed back ingloriously by hand

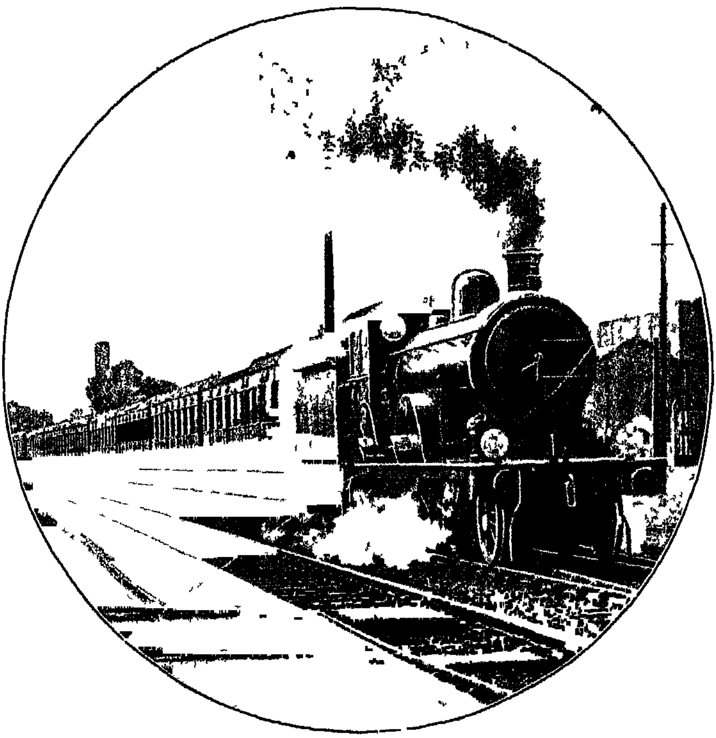
It is as well to be cautious in getting into last carriages, lest they should be slips At St Pancras on a Nottingham race-day, when the same slip was full, a corpulent racing-man, notwithstanding protest, forced his way in at the last moment, and stood making remarks intended to be irritating until the carriage stopped at Luton and the other passengers left him alone "All change here!" said the guard, and when the bookmaker stepped out on to the platform and found the carriage alone in its glory, and the train disappearing in the distance, his look of surprise and disgust—and his language—amply repaid us for our unpleasant journey Nowadays any number of trailers up to eight are slipped, so that there are not only slip carriages but slip trains, and slips are fitted with pneumatic horns as if they were motor-cars, the horns being worked by the feet, and there are head-lights and tail-lights for safety purposes, just as for an ordinary train

Some sixty years ago the old Blackwall and the Eastern Counties joined together in forming the London, Tilbury, & Southend, which was opened in 1854, and after being run by the contractors for twenty-one years, mustered up courage enough in 1875 to undertake its own working Since then have come Tilbury Docks and other developments, and a promising future

Londonwards, the Tilbury's own line ends at Gas Factory junction, continued jointly with the Metropolitan District to Whitechapel By running powers it reaches Fenchurch Street, and, by a branch from Barking, it has its own metals to Woodgrange Park or thereabouts, whence by Forest Gate it runs into Liverpool Street, and, by the Tottenham & Forest Gate, St Pancras From Barking its main line goes straight to Shoeburyness through Southend, giving off a branch to Romford at Upminster, whence another goes south to join the old line that, through Rain-

ham and Purfleet, reaches Tilbury, and so continues to Pitsea on the main line, throwing off a branch half-way at Stanford-le-Hope to Thames Haven, which is nothing like so important a place as at one time it promised to be

This company has 79 miles of track, on which in a



The Norfolk Coast Express approaching Brentwood

year it carries 300,000 first-class passengers, and nearly 29 millions of third-class, besides dealing with, say, a million tons of minerals and merchandise Its carriages are of varnished teak, and its engines were green or black until it recently ventured on a new departure by painting its new ones a neat, light grey that is at any rate smart and

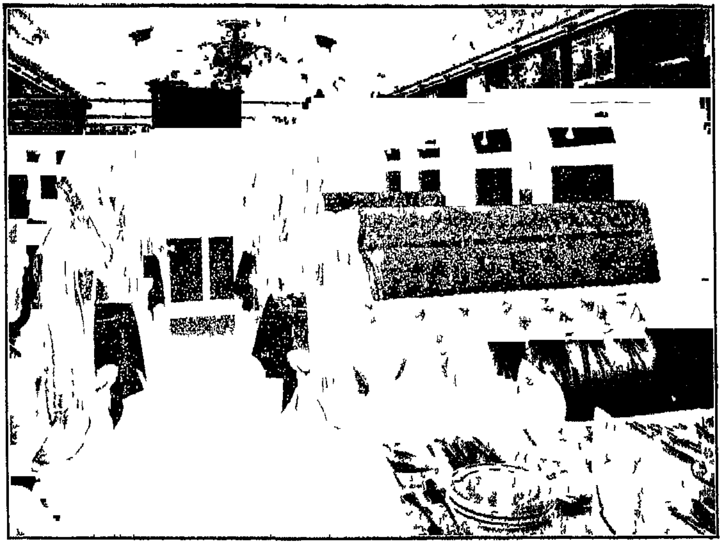
distinctive while it is fresh, and is quakerish enough to have been appropriate on the Stockton & Darlington

It is the smallest of the railways using three London terminal stations, but it is not the shortest railway by any means There are many much less in length, the shortest in the kingdom being the Deptford that belongs to the London Corporation, and measures 484 yards, the gross revenue of which is £10 per annum

It is by running powers on the London, Tilbury, & Southend that the Great Eastern gets from Forest Gate to Barking By the same means on the Midland it runs from Highgate Road into St Pancras , and on the Midland & Great Northern Joint—one of the lines on which the engines are painted yellow—it works in the north-east corner of Norfolk to Sheringham Croydon it reaches by way of the East London and Brighton By its joint line with the Great Northern from March it goes south to Ramsey and Huntingdon, and north through Spalding Sleaford, Lincoln, and Gainsborough, then, by a short stretch of the Great Northern, on to the joint again to Doncaster, and thence by running powers over the Great Northern and North Eastern its trains reach York You will find its through carriages at Rugby, Coventry, Birmingham, Wakefield, Sheffield, Manchester, Warrington, and Liverpool, putting these towns in communication with Parkeston—whence the boats ply to the Hook of Holland, Antwerp, Hamburg, and Esbjerg—or with Norwich, Yarmouth, and Lowestoft

In addition to the Yarmouth trade, and its docks at Lowestoft and quays at the mouth of the Orwell, it has extensive accommodation in the Thames district At Canning Town on Bow Creek it has a big lighterage business, at Poplar there is the Blackwall Pepper Warehouse, dealing mainly with grain and farming sundries, just as Devonshire Street concerns itself with hay and straw and coals Bishopsgate has five acres of warehouse floor space, and

Goodman's Yard almost as many, and then there is Spitalfields, devoting itself largely to eggs and flour At Stratford the company has a little Covent Garden, and at Tufnell Park a sort of minor Deptford for the Islington cattle market close by At Whitechapel it has its coal headquarters, whence it sends the coal trains, as well as the eight trains per day of vegetables and other commodities, by a 40-ton truck hoist taking two trucks at a



First class Dining Saloon on the Cromer Express

time, through the Thames Tunnel on East London metals to New Cross for distribution in the south For quick collection, rapid despatch, and early delivery it ranks with the best Once, for example, it brought up during the night 950 tons of green peas in 300 trucks, and delivered them throughout London before nine o'clock next morning

This sort of thing is not so easy on the Great Eastern as other lines, for ever since the 21st of June 1897 it has been running passenger trains in and out of Liverpool

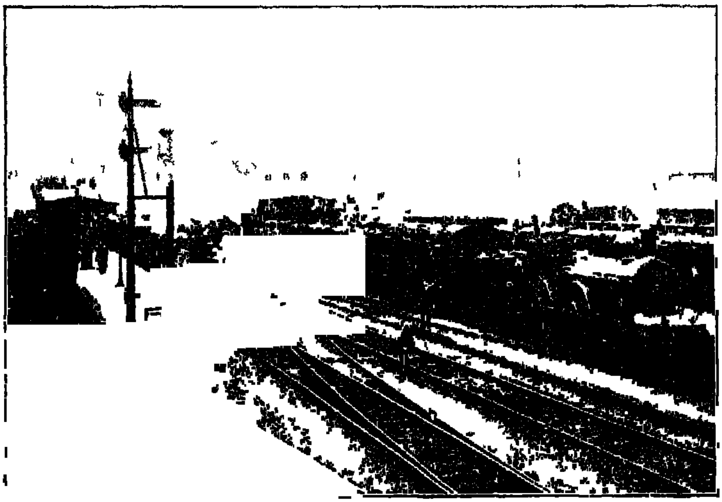
Street all through the night, its booking offices never closing, and in the early morning it has to deal with the workmen's rush to town in the overcrowded carriages we hear of. This overcrowding, however, is not so much due to the lack of facilities provided by the company as to the desire of passengers to travel by particular trains and in particular carriages—the first they reach or those that pull up nearest the exits—and, so far as the last trains are concerned, to the crowd who are not workmen but take advantage of coming cheaply to business though they may have to wait about the City until their office opens.

The profitable working of trains is not so simple as it may seem. Any person can run a train from one place to another when the road is clear but the difficulty is to get it back again fairly well filled. There is nothing more wasteful than an empty train or a train kept idle for hours, with so many carriages, and the engine, as it were in quarantine.

The ideal manager is he who can keep his rolling stock on the move earning money all day long. So many coaches he has to deal with, and none of these must he hang up doing nothing if he can help it. Further, he must fill every seat if he can, but have no passengers standing. On an electric line it really does not matter to him whether the coaches be overcrowded or not, for the power with which he hauls them comes from the central station, and it makes no difference if the load be in one train or half a dozen; but on a line worked by steam it is to his interest to prevent overcrowding, as it increases the weight of the train and throws more work on to the engine than he has provided for, while the other trains that run light require a less powerful engine. The carrying capacity of trains is limited by the length of the platforms and the length of the sidings, just as the length of the wheel-base of the coaches is regulated by the length of the locking-bar, and if more than one train is necessary to carry the passengers it is

ridiculous to blame the company because the passengers insist on going by the last

No account of the Great Eastern, however brief, would be complete without some reference to the twopenny fare question By their Act of 1864, authorising the extension of their metropolitan lines, they are compelled to carry workmen at twopence for the return journey from Edmonton and Walthamstow Now Edmonton is $8\frac{3}{4}$



Lynn Station

miles from Liverpool Street and Walthamstow is 7, and the obligation means a journey of $17\frac{1}{2}$ miles or 14 miles respectively for the couple of pence The railway journey costing so little, there is nothing to wonder at in the acres of small dwellings that have overspread those once quiet rural retreats

There was a time when these twopenny trains paid their expenses without adequate return on the capital spent on the lines over which they run Then by the increase of the traffic and the consequent increase in the

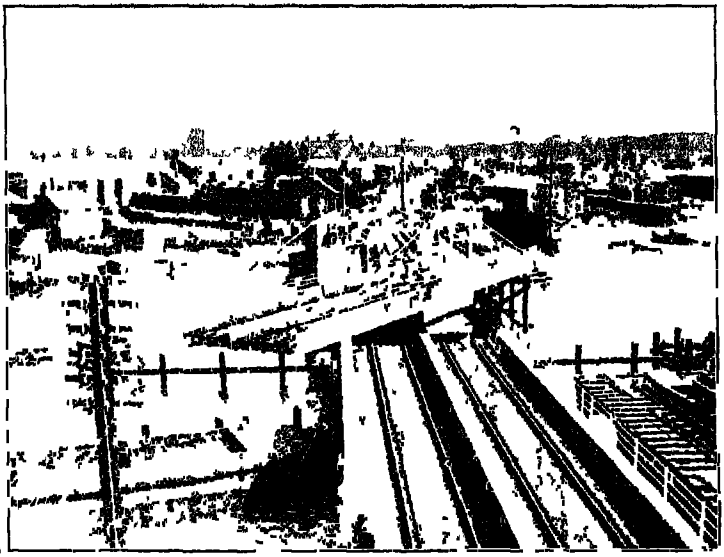
capital, due to the enlargements needed for the safe working of the greater number of trains, the return on the capital became less, and then the rise in working expenses wiped this out altogether, so that in 1899 the receipts equalled the working expenses and left nothing over Soon the working began to cost more than the receipts, and as that cost of working has increased the loss has become so great as to more than counterbalance the profit made on the ordinary traffic

The cost of working a railway is not the same all over the system In the neighbourhood of large towns it is always greater than in the country districts, and in the suburbs of London it is much greater than elsewhere, owing to the short sections, the shorter hours of labour, the higher rates of pay, the heavy train loads and frequent stoppages, the short mileage worked by enginemen, the greater cost of coal in London, the heavier rating, and the larger number of stations on the line

The exact proportion of the additional cost thus incurred was very carefully investigated by the Great Eastern Company in 1903, and these investigations proved that the cost of working in their London district was at least 21 12 per cent higher than the average of the whole line in addition to which there are other factors impossible to estimate, which bring the actual cost of working still higher This figure was submitted in evidence to the Royal Commission on London Traffic and to the Select Committee on Workmen's Trains, and its accuracy has not been questioned In the Board of Trade report on London Traffic for 1907 the actual cost for working is put as at least 3s 10 2d per train mile, and if we set against it the 2s. 10 6d per train mile, which is what the receipts amount to, we can quite understand why the Great Eastern wants no more twopenny workmen's fares, which some people are so anxious to burden them with The policy that forces a company to carry passengers at an unprofitable

fare, and then raises the rates and otherwise adds to the expenses to increase the loss, must inevitably end in trouble, not only to the company but to the community, which gains nothing by the company's ruin

In regard to the London dock and riverside traffic, it has been said that the Great Eastern has a monopoly, a description which the company does not accept It urges



Carlton Colville Swing Bridge

that as the North London has lines into Millwall and East and West India Docks, with running powers to other companies, and the Great Northern, London & North Western, and Midland have running powers over the Great Eastern, their lines in this district constitute not a monopoly but a public highway

At one time, prior to the advent of the Midland and Great Northern Joint lines into Norfolk, and the severe competition which has recently arisen in the London and suburban districts from electric trams and motor omnibuses,

the Great Eastern system as a whole might have merited the title of a monopoly, although, serving as it does such a considerable extent of coast, it always has sea competition to meet Still, it was formerly somewhat similarly situated to the North Eastern, which frankly accepts the description, and just as the Great Eastern has the Tilbury line in its south-eastern corner, so had the North Eastern the Hull & Barnsley until the recent agreement, and the North Eastern has the Lancashire & Yorkshire in its south-western corner, answering in a similar way to the North London

This, however, is comparing large things with small, for the Lancashire & Yorkshire is a great line, and the North London, which has become officially, as it has always been in reality, an extension of the North Western, is only 12 miles long Originally it was The East and West India Docks and Birmingham Junction Railway, its object being to give the North Western access to the trade of the Thames, which the South Western had secured at Nine Elms and the Great Western had endeavoured to get at Vauxhall Beginning in a small way, the minerals and merchandise business increased until by extensions the passenger traffic was developed to surpass it and became of such importance that goods trains had to cease from running during certain hours of the day, and now, owing to tram and other competition, passengers are falling off while goods are slowly growing Short as the line is, it carries more than half a million passengers a week, and handles 1½ million tons of minerals and 1,768,000 tons of miscellaneous goods in the course of a year

By minerals we mean mainly coals, and this reminds us of the enormous quantity stacked on the line at Stratford as a reserve, apparently in case of a strike or a break in the communications The Great Eastern, however, has not a large coal-carrying business, though it has been trying to obtain one for years Coal was the main cause of its

wars with the Great Northern which ended in the peace of 1879, whereby the joint line to Black Carr junction was finally agreed upon

Our railways carry about 400 million tons in a year, though only 261½ million tons are raised, which means that half the output is recorded twice Of these the North Eastern carries 48 millions and the Great Eastern 7½, almost the same amount as that dealt with by the Alexandra line at Newport, which is only one of the South Wales group that carry some 50 million tons between them In those parts the handling of coal for wagon loads and ship cargoes is a fine art To see it at its best you must go to Newport, or Cardiff, or Penarth, or Barry No tipping a ten-ton wagon down a ship's hold in these days There is a crane to every hold in the ship, and to the end of its chain is fixed a giant coal-scuttle The scuttle is laid on a yielding platform in a pit in such a way that its mouth is fed from a short shoot just long enough to bridge the gap between it and the rail-end The wagon runs up, kicks up behind, shoots its ten tons into the scuttle, which is hauled up and swung down into the vessel, where the conical bottom opens and spreads the coals around as gently as you would put them on the fire But before it reaches the scuttle it has to be put into the truck at the collieries, and the way that is done is quite as ingenious as it is in South Yorkshire, Derbyshire, and Nottinghamshire, whence much of the coal comes that goes down the lift at Whitechapel

Curiously enough, the 7½ million tons carried in every part of its territory by the Great Eastern is almost exactly the total quantity brought to London by all the railways put together, the rest of the 16 million tons consumed by the metropolis reaching it by sea or, in small quantities, by canal That most London coal is sea-borne is something not generally known

The first to wake up the Eastern Counties was George

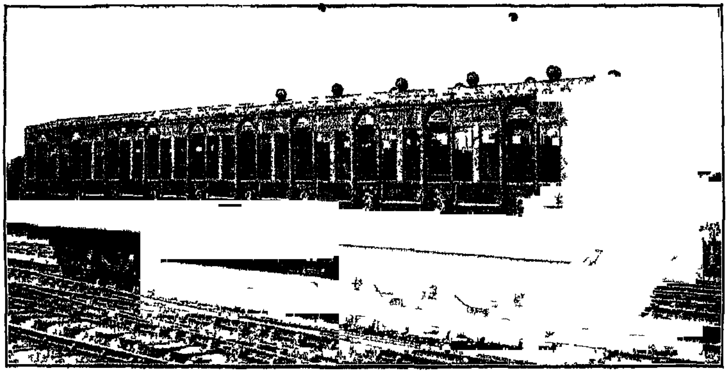
Hudson, who during his chairmanship effected many reforms, though unfortunately the railway king did not reign long enough To him, of course, were due many of the amalgamations, for amalgamation was everywhere the keynote of his policy He it was who founded the locomotive works at Stratford opened in 1848, Hudson's Town as the place was called for years, which now cover 55 acres and give employment to some 5000 people

Many notable engineers have been locomotive superintendents of the company Following Braithwaite came William Fernihough—"the power of the engine is limited by the strength of the rail," said he, and then after an interval came in 1850 the builder of the first engine at the works, John Viret Gooch Then in 1856 came Robert Sinclair, the first of the Great Eastern men, followed by William Kitson in 1865, to be next year succeeded by S W Johnson who went to the Midland in 1873, when William Adams took over, to leave for the South Western in 1878 Then for three years followed Massey Bromley, to be followed in 1881 by T Wilson Worsdell who went to the North Eastern in 1885, making room for James Holden who was succeeded by his son, S D Holden, in January 1908

Some weird little engines were used by the independent companies, and the early Eastern Counties array was not much to be proud of, in fact it was not until Sinclair took the reins that anything not best forgotten was done He brought out a class of singles noteworthy in their day—cylinders 16 in by 24 in, 87-in drivers, 45-in leaders and trailers, heating surface 958, weight 32 tons—which were built by Fairbairn and—of all people in the world for an English company—Schneider of Creuzot! Another well-known class of his was his 8-wheeled tanks, 2–4–2, cylinders 15 in by 22 in, coupled wheels 66 in, leaders and trailers 43 in, each pair carried on a Bissell truck so that the rigid wheel-base was only 6 ft. Further, the tanks of these

engines were beneath the boiler and between the frames, and there was a cab that so pleased the enginemen that they presented the designer with a testimonial in which they greeted him as the inventor of the cab as applied to locomotives

Mr Johnson's first effort was a class of 4–4–0, with cylinders 17 in by 24 in, bogie wheels 43 in, coupled wheels 79 in, heating surface 1200, which began a new era They were large engines, and the appearance of the turn-out was rather ridiculous owing to their being



A new Third class Carriage to carry six a side

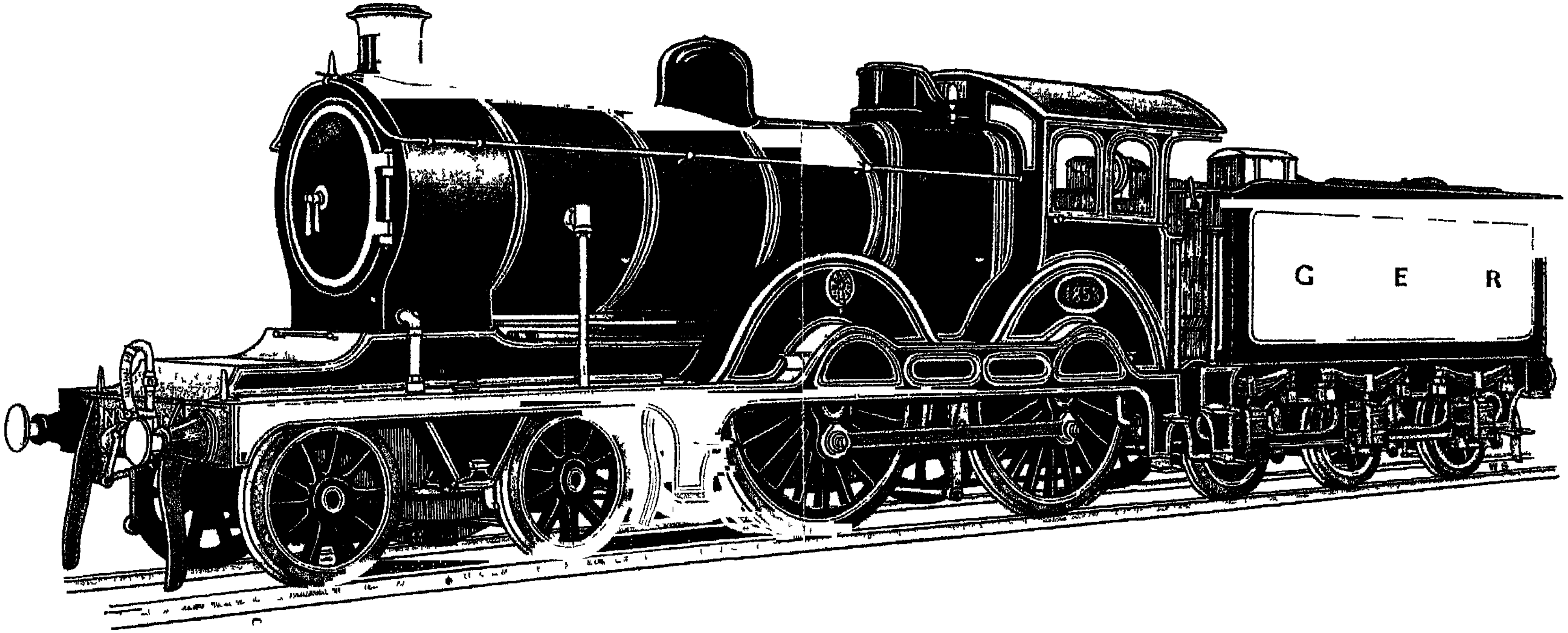
accompanied by the very small tenders with wooden frames which had been at work for years This state of things, however, did not last long, and soon the Great Eastern engines became characterised by continuous improvement in power and appearance

Mr Adams followed, and carried on the improvement Mr Bromley is best remembered by his class of single expresses, some of which were built by Kitson and some by Dubs They were 4–2–2's, with cylinders 18 in by 24 in having valves on top worked by a rocking shaft, 90-in drivers, and a heating surface of 1226, the engine weighing 41 tons 13 cwt, and engine and tender 77 tons 12 cwt.

More useful engines, however, were his bogie expresses of the 600 class, with cylinders $17\frac{1}{2}$ in by 24 in, and 90-in driving wheels, and his 0-4-2 tanks—and with regard to tank engines it may be as well to note that, though space does not admit of our saying much about them, they form half of the engine stock on some of our great lines, and in some cases work more than half of the fast passenger traffic

The first of them was the Novelty already mentioned, carrying the water in a tank under the boiler and the coke in baskets on the platform She might be described as a well-tank, though the present well-tanks carry the water in a tank beneath the footplate, side-tanks carrying it mainly in tanks on the frame plates over the driving wheels, and saddle-tanks having it on the top of the boiler The Novelty, however, led nowhere, for the two engines "after her style," as ordered for the Liverpool & Manchester—the William the Fourth and the Queen Adelaide—had 4-wheeled tenders pushed along in front of them, and the tank engine may be said to have begun with the Ariel's Girdle on the Bentley and Hadleigh branch of the Eastern Union

This famous little well-tank was in the 1851 Exhibition along with the Little England, "designed," as Robert Hunt said, "with the same object, namely, of obtaining speed, safety, and economy in express and other quick traffic" The Ariel's Girdle was in 1856 transferred from the Eastern Union to the St Ives branch of the Eastern Counties, on which in 1849 there was but one train a day, and owing to an increase of business in the first few months—which went no further—the service was doubled, the other train being a composite coach drawn by a horse This mixed traffic of two trains per diem went on for six years, and it was to replace the horse that the Ariel's Girdle was obtained She was designed by Bridges Adams, and was a 4-wheeler with 5-ft drivers until, in 1868, she was altered



THE GREAT EASTERN RAILWAY

EXPRESS PASSENGER LOCOMOTIVE, No 1853

Designed by Mr J Holden M Inst C E, M Inst M E

Boiler	Length	11′ 9″
	Diameter	4′ 8″ / 4′ 7″
Cylinders	Diameter	19″
	Stroke	26″
Tubes	No	287

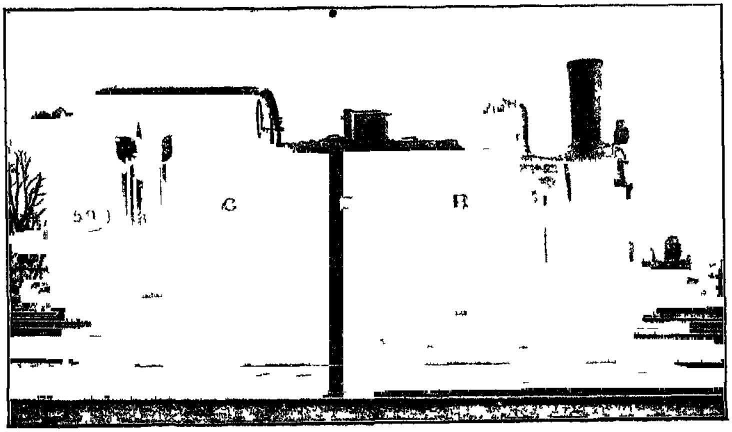
Fire Box	Length	7′ 0″
	Width	4′ 0½″
Heating Surface	Tubes	1588 88 sq ft
	Fire box	117 7 ,,
	Total	1706 58 sq ft

Diameter of Wheels	Bogie	3′ 9″
	Coupled	7′ 0″
Grate Area		21 6 sq ft
Working Pressure		180 lb per sq inch

		Tons	Cwt
Weight in Working Order	Engine	51	14
	Tender	39	5
	Total	Tons 90	19
Water Capacity		3450 galls	
Coal Capacity		5 tons	

to a 6-wheeler with four wheels coupled, the wheels measuring 4 ft, in which form she ended her days on the Millwall Extension in 1879

The rail-motor also began on the Great Eastern with Samuel's Little Wonder, built as an inspection car for the officials, which was first used on the 23rd of October 1847 in a trip to Cambridge In length 12 ft 6 in, with the frames hung below the axles of the four 40-in wheels, her floor was only 9 in above the rails, and the two cylinders, one on each side of the vertical boiler, were 3½ in by 6 in



A useful little Tank Engine for Suburban Traffic

The boiler, 4 ft 3 in in height and 19 in. in diameter, had 35 tubes with a heating surface of 38 sq ft, that of the circular firebox being 5½ sq. ft She carried seven passengers, the water-tanks for 40 gallons being under the seats

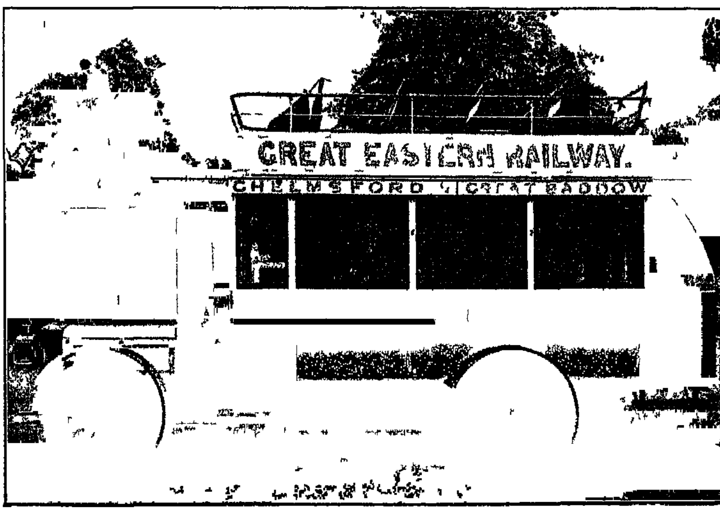
She weighed about a ton and a quarter, travelled at from thirty to over forty miles an hour, and was so successful as to lead on to the Enfield, designed by Bridges Adams for the Enfield branch This was a 4-wheeled tank with a 4-wheeled carriage mounted together on the same frame The front and hind wheels were flanged, but the

5-ft drivers and the pair of wheels behind them were without flanges The six carrying wheels were a yard in diameter, the cylinders were 7 in by 12 in, and carried outside on the frame at the base of the smokebox, with the buffers just above them The boiler, of the ordinary locomotive type, was 30 in in diameter, and double as long, and contained 115 tubes having a heating surface of 230 sq ft, the firebox providing 255 sq ft The coach was a composite, with two first-class compartments in the middle and a second-class at each end The height above rail-level was only 9 in, hence the placing of the buffer-beams on rising brackets The branch becoming busy, two ordinary carriages were added, so as to form a short train, and the motor was also used for hauling the goods and coals On a trial between Norwich and London the Enfield made the best record up to then, 126 miles in 3 hours 35 minutes, and on the 14th of July 1849, she replaced the ordinary engine on the 10 a m train from Shoreditch to Ely, and completed the journey in eight minutes under time

The compound engine originated at Stratford with Nicholson & Samuel's patent in 1850, and it had its second start in 1884 when Mr Worsdell built No 230, a 4-4-0 passenger engine with two inside cylinders, the high-pressure being 18 in and the low-pressure 26 in, the stroke being 24 in, the bogie wheels 37 in, coupled wheels 84 in, working pressure 160 This was followed by a 6-coupled goods engine, and, after a long series of trials, ten more compound passenger engines were built in 1885, the year that the inventor left for the North Eastern where the system was first introduced on a large scale

Mr James Holden during his long reign added largely to the blue brigade, and the black one too, and left them at a high pitch of excellence One of his great achievements was the introduction of oil fuel The company, having adopted oil-gas for lighting its carriages with, were turning the waste product into the waters of the Channelsea and the

Lea when the sanitary authorities interfered, and means had to be discovered for getting rid of it elsewhere or utilising it Mr Holden resolved to try it as a substitute for coals in his engines He led it from a tank in the tender by pipes to two injectors in the firebox plates some fourteen inches above the fire-bars, on which he kept a fire of small coal To each injector he fitted two separate steam supplies, one



The Great Baddow Motor-Bus

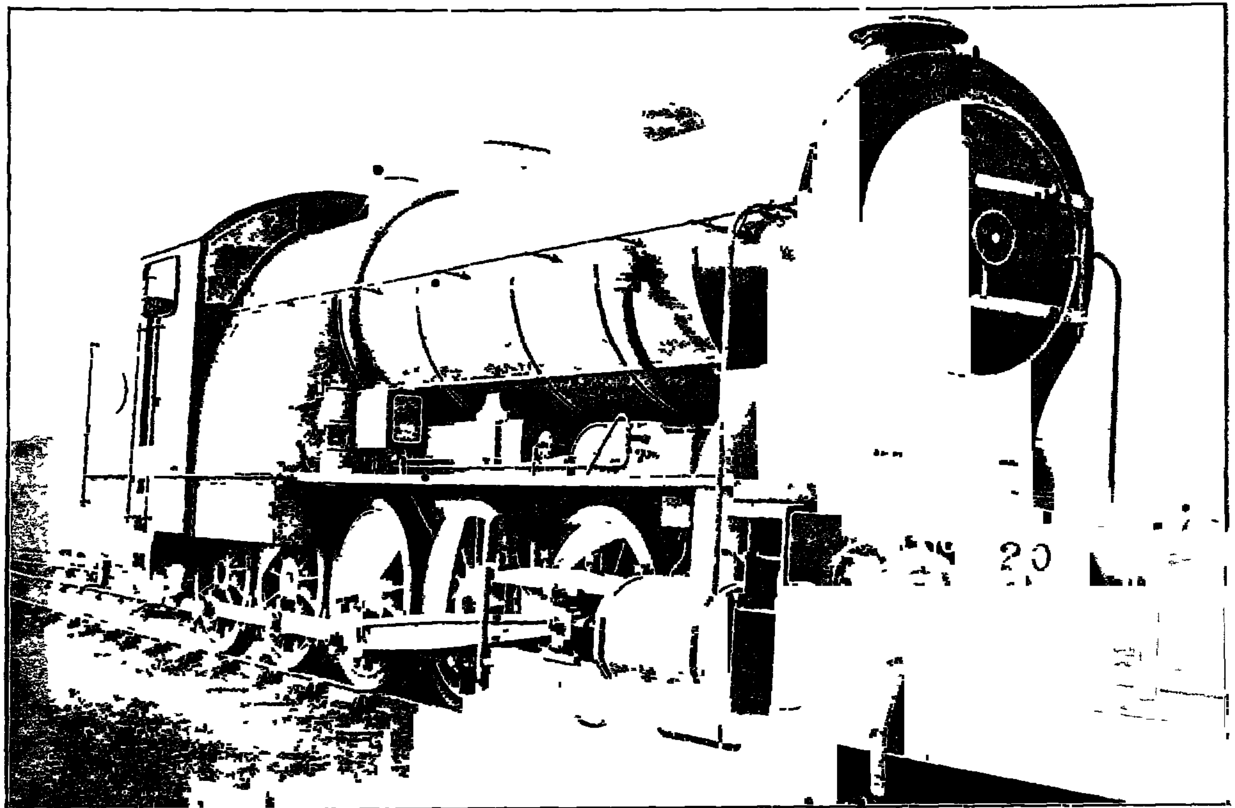
for inducing and atomising the liquid fuel by a central jet, the other for supplying air to the atomised fuel by means of a ring of small jets around a blower placed near the nozzle He thus ensured perfect combustion, and distributed the spray so well that no fire-brick was necessary, and he applied it so effectively that one ton of oil was equal in heating effect to twice the weight of steam coal , while the contrivance had the great advantage of allowing of coal being used at any time the supply of liquid fuel ran short

Petrolea was the first of the oil-burners, and so successful was that engine that the system was generally adopted.

She was a 2–4–0, cylinders 18 in by 24 in, leading wheels 48 in, coupled wheels 84 in, heating surface 1230, her weight being 42 tons, that of the tender 32½ tons, and the tender carried 500 gallons of oil One of the later of the oil-burners is the Claud Hamilton, a 4–4–0, with cylinders 19 in by 26 in, bogie wheels 45 in, coupled wheels 84 in, heating surface 1630, pressure 180, boiler 4 ft 9 in by 11 ft 9 in, her 6-wheeled tender having 49-in wheels and carrying 2790 gallons of water and 715 gallons of oil The newer engines have the Belpaire firebox, the first so fitted being No 1850, which has a heating surface of 1706, and similar internal details to the Claud Hamilton This similarity of parts is characteristic of the present Stratford system, the three largest classes of engines differing only in their wheels

One engine which has been modified was of a class by itself This was the 3-cylinder 10-coupled tank, known as the giant Decapod, built to show what steam could do in competing with electricity so far as starting quickly was concerned—an engine in fact that with a 315-ton train could start from a state of rest and in half a minute be travelling thirty miles an hour It had ten 54-in wheels, the tyres of the middle pair being flangeless, as those of the old broad-gauge engines used to be Two outside cylinders, each 18½ in by 24 in, drove on the middle pair of wheels, whilst a third cylinder of the same dimensions, placed between the frames, drove on the second pair The boiler was 5 ft. 3 in in diameter and 15 ft 10⅞ in between tube-plates, and the heating surface 3010 sq ft The Decapod would have done the work it was built to do, had the permanent way and bridges been strong enough to carry it with safety, but the old bridges were designed to carry much lighter loads, and a great deal of money has been spent to strengthen the bridges to carry the heavier engines now in use on this line

The Railway Engineers Association have now fixed a



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MR JAMES HOLDEN'S "DECAPOD," NO 20

maximum load to be carried by the bridges of the future, thus adding an important link to the future standardisation of railways Weight does not always mean power There are engines a dozen tons lighter than others having the same heating surface, the same cylinder capacity, and the same tractive force, which are quite as powerful, the difference being only in the steam pressure, which means a general increase in dimensions, in boiler plates, crank axle, piston, connecting rod, and other things, and there is a great difference of opinion as to whether this extra pressure pays.

A goods engine can be heavier than a passenger engine because as a rule it is not worked at high speed, in fact for slow haulage the heavier it is the better, providing the track can stand it • Out in America, where crossings are level, goods engines are becoming gigantic The Decapod would have been quite overshadowed, for instance, by the ponderous articulated Mallet, built for the Atchison, Topeka & Santa Fé—a double-engine single-boiler twenty-wheeler Of this the sixteen drivers are coupled in two groups of eight each, and there is a two-wheeled pony truck at each end The weight on the driving wheels is 22 7 tons per axle, that is 182 tons on them altogether There are two high-pressure cylinders 25 in in diameter, and two low-pressure cylinders 39 in in diameter, the stroke in both cases being 28 in The boiler is 7 ft in diameter and 34 ft 6 in long At a distance of 6 ft 6 in. from the firebox is a combustion chamber 4 ft 6 in long, into which deliver 246 3-in tubes, and from which run to the smokebox 454 2¼-in tubes which are 23 ft long There is a superheater with vertical tubes in the combustion chamber The firebox is 11½ ft long and 9½ ft wide outside In fact there is good provision for working up to the 215 lb per inch of her steam pressure, the grate area being 89 sq ft and the total heating surface 7839 sq ft! But even this mighty machine has its limitations, for the heating surface is so large and the evaporation so

great that a stop has to be made every five-and-twenty miles to fill up the tender

Some of the Great Eastern engines are fitted with power reversing gear, actuated by the Westinghouse pump without interfering with its main duty, that of working the continuous brake An engine to be of any practical use must be able to run either forwards or backwards, and it is reversed by admitting the steam to the other end of the cylinder first, whichever that other end may be When the crank is at rest it will be moved round in one way by admitting the steam at the top, and the other way by admitting it at the bottom , and on the valve motion by which this is effected depends the control of the admission so that the steam can be worked expansively, that is cut off at any part of the stroke to ensure that the amount used is in proportion to the work required

The control of the power is clearly the most important part of the engine, but it could only be satisfactorily explained by diagrams and is much too technical to be enlarged upon here Let it suffice to say that at first engines were reversed by a loose excentric working on a forked lever which was in connection with the valve stem When it was desired to reverse, the engine was stopped, the lever lifted out of gear, and the valves moved by hand till the excentric reached a position that gave the opposite motion and the fork again dropped into gear When there were two cylinders there were two levers This served the purpose at moderate speeds, but at high speed the levers were in danger of jumping out of gear It was to remedy this that, in 1842, William Howe invented what is generally known as the Stephenson gear, in which each cylinder has a backward and forward motion excentric, with the rods connected by a curved slotted link adjustable by a shaft and lever

There had been over a dozen devices adopted and abandoned before this, and there have been quite as many

since Two years after Howe came Walschaerts with his first proposal, that made no progress until the one excentric

Signal Cabin at Bethnal Green West Junction.

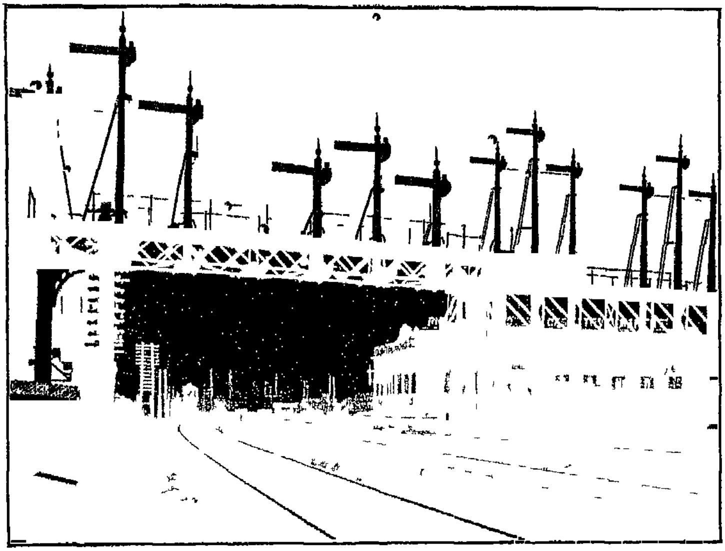
gave place to the return crank in 1859, since when it has slowly worked its way into favour for its adaptability

for steam chests above or below, its excellent distribution of steam, and its being so accessible when used with outside cylinders In 1848 Daniel Gooch introduced his fixed link motion, in which the engine is reversed by raising or lowering the quadrant block in the slot, the block being connected with the valve stem by the radius rod Then in 1855 Allan brought out his straight link actuated by two excentrics, and in 1879 came Joy with his linkages in which the number of working parts was reduced, the gearing made lighter, and the strains made central, excentrics being dispensed with and the movement obtained from the connecting rod This gear is now much in favour owing to its economy in construction, the prolonged expansion given by it, as well as the high mean effective pressure it provides on the pistons, its only drawback being the wear of its pins and slides, and those who would appreciate its ingenuity can study it in the motion diagrams at South Kensington

Great Eastern trains are long, though they are none of them so long as the Cambridge platform, which measures nearly a quarter of a mile, and they are heavy, particularly in the suburbs, where the coaches take six a side to deal with the crowds using workmen's tickets that come to London in an hour or two every morning and leave it within a few hours every night, and the main-line trains are also heavy, such, for instance, as the Norfolk Coast express, a 317-ton train 638 ft long, with its dozen vestibuled corridor cars, including its first and third restaurant cars and a kitchen car—quite a triumph of compactness and ingenuity—every one of which has its own electric light outfit run from a dynamo driven from its own axle. What may be called the travelling hotel business is excellently worked on the Great Eastern, not only does the company cater for your breakfast, luncheon, tea, and dinner, but it even adds a supper car to its theatre trains.

The Great Eastern time-tables, with their multitude of

trains, occupy fifty pages of Bradshaw and fill them handsomely. Those who would know how our railways have grown can realise it most readily by comparing that indispensable monthly, containing over 900 pages, with a copy of earlier date Few who consult it are aware that it originated in the map which is generally treated with such scant courtesy



A Signal Gantry at Stratford

George Bradshaw, who was born at Windsor Bridge, Pendleton, in 1801, began life as an apprentice to an engraver In 1830, when in business for himself as an engraver and printer, he issued, as canals were then flourishing, a map of inland navigation, the first of three which proved most useful to canal passengers When railways were taking the place of canals he, in 1838, followed these three with his map of the railways of Great Britain, and on the 25th of October 1839 he started his *Bradshaw's Railway Time-Table and Assistant to Railway Travelling.*

This small 18mo of 24 pages, "published by the assistance of several railway companies," became next year *Bradshaw's Railway Companion*, and contained several maps and a few tables that were kept up to date by time-sheets, monthly and otherwise, which appeared on whatever day of the month he could manage

The publication soon became recognised as more or less official, and, in a short time, in response to Bradshaw's repeated appeals, the railway companies, with a view of obliging him, agreed to begin alterations in their train service on the first of the month instead of on any day the idea occurred to them If Bradshaw had done no more than this he would deserve remembrance

Having assured himself of being regularly supplied with copy, he abandoned his old correction-sheets, and for December 1841 produced the first number of his famous *Guide*, which has appeared regularly ever since It was heartily welcomed from the first, particularly by the railway people, and on account of it—strange to relate—he was elected an Associate of the Institution of Civil Engineers, in February 1842, out of gratitude for having done so much to help on railway enterprise

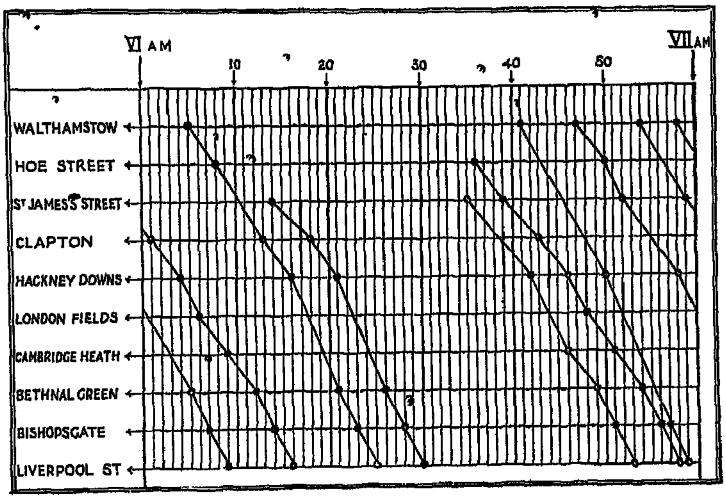
His was not, however, the first railway guide nor the first combined guide Prior to it there had been guides to the separate lines, and these were not only in book or pamphlet form, for some of them were medals to be carried in the pocket, with the stations and times, and in some cases the distances, given The idea to which he owed his success was to treat the time-table as being made to be changed, and keeping abreast of the changes

Time-tables appear to have begun as separate way-bills for each train, as used by the coaches and canal boats. The next step was to print two or three on each bill, and these being placed side by side, vertically or horizontally, gradually led to the columnar form which in so many varieties in sheet and pamphlet the companies have to prepare and

use for their own purposes—and publish at a loss for the information of the public, who imagine there is a profit on the pennyworth or twopennyworth, as the case may be, whereas it only pays as an advertisement

Diagrams are now being used in railway work wherever possible, and one of the first of the diagram methods to be introduced was that of stringing the trains, "the visualised time-table" as it has been called. In this a long

MAKING A TIME-TABLE



The Train Board

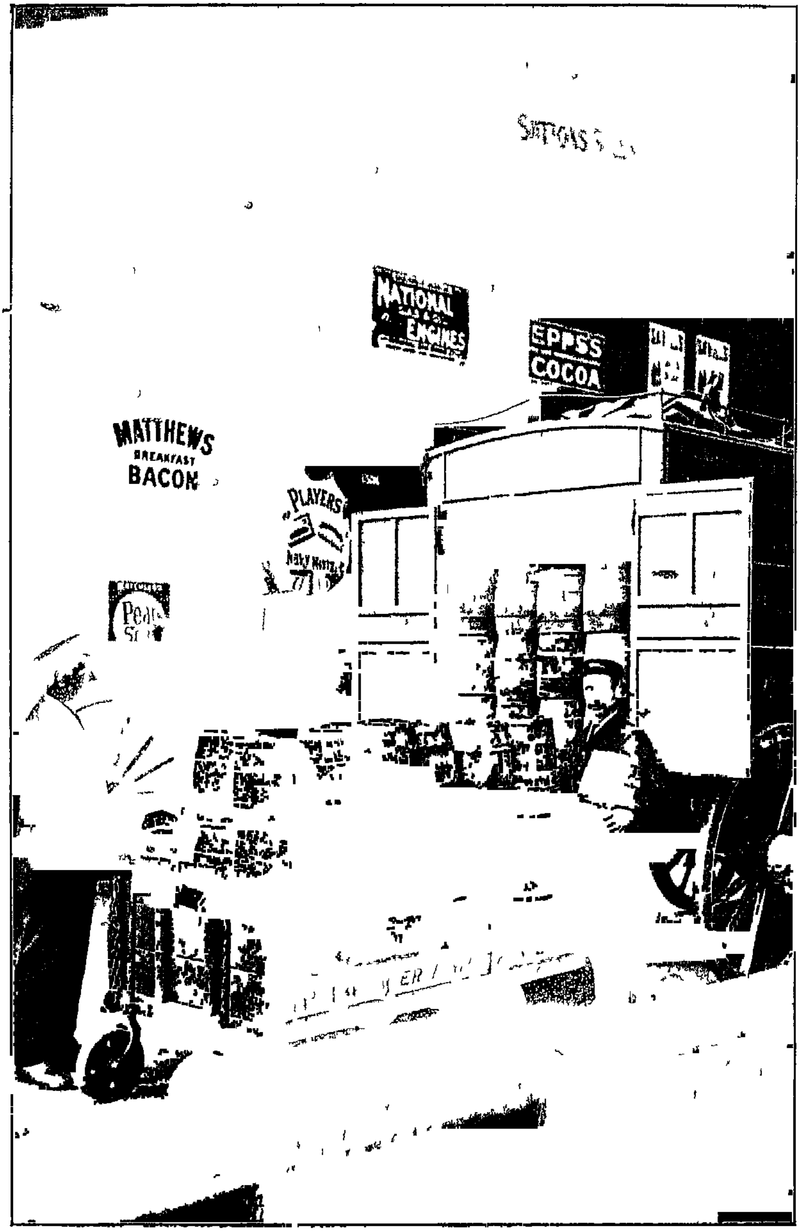
board is divided vertically into twenty-four equal spaces, one for every hour of the day Each of these hours is similarly divided into sixty minutes, the half-hour, quarter-hour, and five-minute intervals being marked with darker lines. The hour lines are marked from I to XII, and I to XII again, so that by joining the outer edges, if it were a strip of paper, you would have a cylindrical clock-face, as in the automatic register of an aneroid barometer This time-scale is divided horizontally into a distance scale, the stations and junctions being placed on the margin in

their relative positions, and thereby you have a blank time-table, which you proceed to fill up not by writing figures but by sticking in pins

As a specimen hour's work let us take the up-trains from Walthamstow (Wood Street) between six and seven o'clock in the morning The first train to come in is that leaving Chingford at 5 56, which reaches Walthamstow at 6 5 Where the 6 5 line on our chart crosses the Walthamstow horizontal line we drive in a pin, at Hoe Street at 6 8 we put in another pin, as the train runs through St James's Street our next pin goes in at Clapton at 6 13, three minutes afterwards comes a pin at Hackney Downs, then, passing London Fields and Cambridge Heath, we put in our next pin at 6 21 at Bethnal Green, the next at Bishopsgate at 6 23, and the last at Liverpool Street at 6 25 As we have plotted the 6 5, let us plot the 6 14 from St James's Street, the 6 35 also from there, the 6 36 from Hoe Street, the 6 41 from Walthamstow, and the 6 47, 6 54, and 6 58, none of which, except the 6 36, stop at all stations

Now join up the pins, marking the progress of each train, by a piece of coloured thread, and you will see at a glance where every train ought to be on the line at any given moment. Use a different coloured thread for each sort of train, put in two pins for arrival and departure in cases where the train waits for another to pass it, and you have the up traffic of the line in that section graphically displayed, and with other pins and other threads you can run in the coal trains and goods trains and fish trains, or whatever they may be, and make your table as complicated as you need, but it will always show where changes can be safely effected, and other trains worked in, which is what the maker of time-tables wants to know

His is no easy task, particularly in the spring and autumn when the chief alterations are made, for then it is that the character of the traffic changes, goods being dominant in winter and passengers in summer. "No one," as



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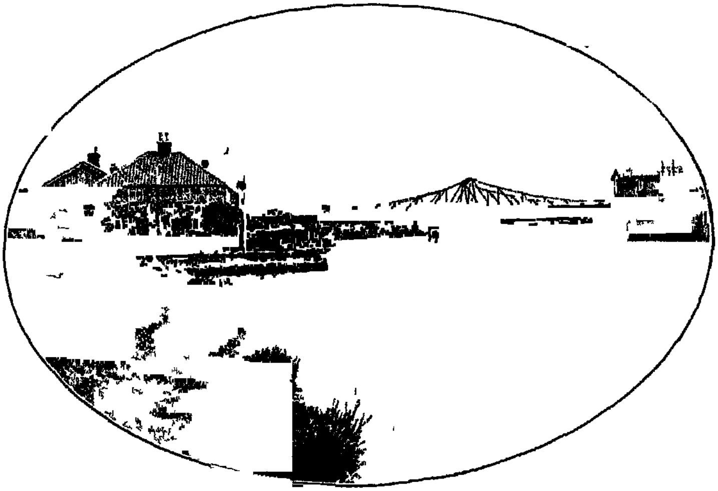
SEA WATER ARRIVING AT LIVERPOOL STREET FROM LOWESTOFT

Findlay said, "who has ever glanced with an intelligent eye at the time-table of a great railway, will be surprised to learn that this operation is one of the most complicated nature, and involving great labour and considerable skill This will be apparent if it be borne in mind that, supposing, for instance, a train running from London to Scotland is altered in its timing ever so slightly, it involves the necessity of altering all the trains running on branch lines in connection

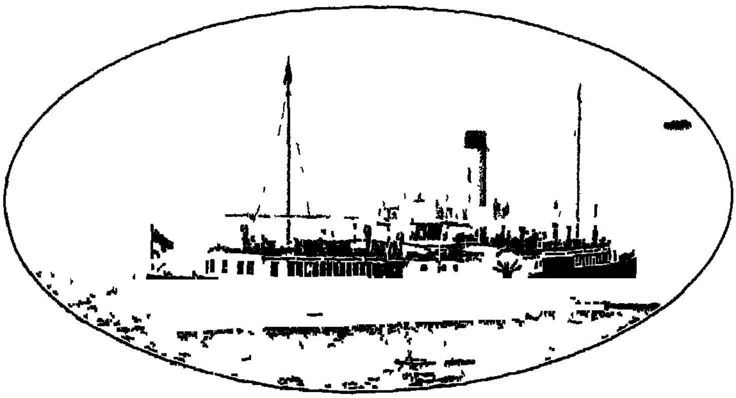


Reedham Swing Bridge

with it, and many other trains which are affected by it A train service is, in fact, like a house of cards, if the bottom card be interfered with, the whole edifice is disarranged, and has to be built up afresh Remembering all this, and the pressure under which the work must be done, the wonder is not so much that an occasional error creeps into a time-table as that such marvellous accuracy is, on the whole, arrived at" And such errors, few as they were, have become much fewer since the introduction of the train-board

The book published by some companies at a penny,

and by some at twopence, which you buy at a bookstall, or the booking-office, and find in every club and hotel, is not the chief time-table printed by the railway company, but quite a small thing compared with the working time-table used by the company's men, which, on any of our great lines, forms a volume of three or four hundred pages, requiring much more alteration This gives the running of every sort of train, passenger and goods, and even the empties, and in some cases the light engines on their way to and from work, the times at every station they stop at and run through, and the times of



The River Service from Ipswich to Felixstowe

their waiting and shunting at every station and siding, and into it as insets go the leaflets issued in a hurry dealing with the excursions and specials arranged for during the month, and not known of when it went to press Some of these way-bills, as they would have been called in the old days, are masses of detail, particularly that of the royal train, which forms quite a booklet of half a dozen closely-printed pages, giving the time of the train past every signal-box from one end of the journey to the other

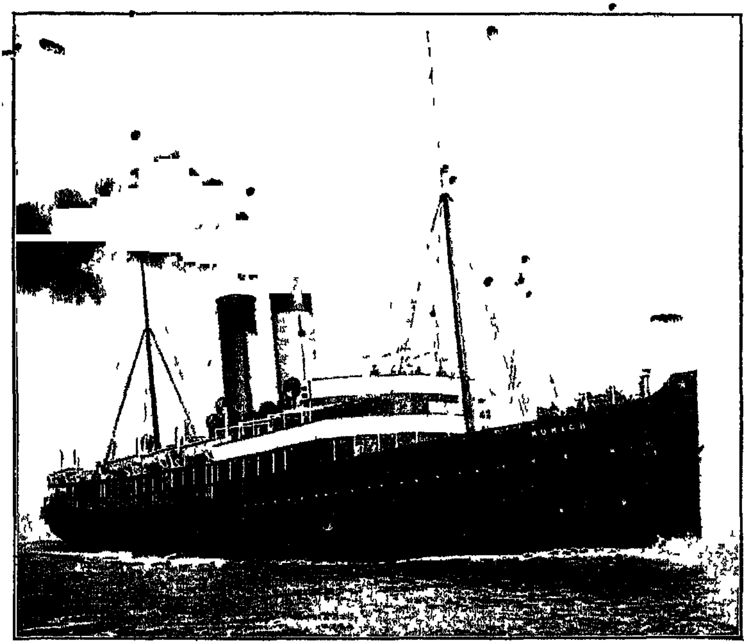
Sandringham is on the Great Eastern,—Wolferton being the nearest station,—the royal trains being generally

worked not from Liverpool Street but from St Pancras by way of Kentish Town and South Tottenham, though it sometimes happens that the train arrives on the company's metals at some more distant junction Of other short notice specials it has a fair share, but its ordinary work is not so broken in upon as on some lines. Excursions of all lengths it has many, to the coast, to the Broads—which is much the same thing up Norfolk way—and to almost everywhere on its system beginning with the Forest and radiating beyond, and of course it has its race-days, principally at Newmarket, where there are eight meetings a year, and a group of training stables meaning horses by train to the number of over 12,000 a year

A more hopeless railway there never was when in 1867 Lord Cranborne, who the same year became Marquess of Salisbury, was implored to accept its chairmanship By his reputation and conspicuous ability he gave it hope and restored its credit, and raised three millions to give it a fresh start, from which it has never looked back In 1875 came the man to take advantage of the better prospects and make them better still The one outstanding thing that crippled the company was its want of punctuality, and this he set to work vigorously to remedy Such a tumult of growls against hustling and petty preciseness had not up till then been heard in the east, but Punctuality Parkes went on his way regardless of protest in clearing out the unpunctual, and drilling the staff into the belief that time-tables are not intended to be works of fiction but of fact And he succeeded, and, loyally helped, he put the line on another plane of existence He it was who abandoned Bishopsgate of evil memory and took the terminus to Liverpool Street, he it was who put the clock there that there could be no mistake as to what the time was at every station and in every man's pocket. Parkeston, the Great Eastern port for the Continent, he also made, and it is named after him, and there you start by steamer for the Hook of

Holland or elsewhere just as punctually as you do from London by train

The Great Eastern Company's fleet consists of 8 passenger boats, 4 cargo boats, and the 3 small paddle steamers that ply on the river between Ipswich, Harwich,



Great Eastern R M Steamer *Munich*—Harwich and Hook of Holland Service

and Felixstowe Three of its Channel steamers are driven by turbines, the others being twin-screw boats of the old type All the passenger steamers are fitted with wireless telegraphy and submarine signalling appliances, and are well-known examples of what may be called the liner type, with passenger accommodation of the best.

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